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ONTARIO

Department of Education

Courses of Study

Grades IX, X, XI and XII

GENERAL SCIENCE

AND

AGRICULTURAL SCIENCE

Issued by Authority of
The Minister of Education

COURSES OF STUDY

For

Grades IX and X

in

Collegiate Institutes, High and Continuation Schools, Public and Separate Schools, Vocational Schools (Grade IX only)

GENERAL SCIENCE

Objectives

(a) To arouse, encourage and utilize curiosity in natural objects and phenomena, in order to develop an understanding of the elementary facts of nature;

(b) to cultivate discriminating observation, and the ability to carry observation to a logical conclusion;

(c) to cultivate precise and orderly expression;

(d) to develop an appreciation of nature;

(e) to help towards rational and healthy living.

The realization of these objectives demands active participation by the student. It is suggested that this may be achieved by the adoption of the problem method in which experimental work is undertaken as a means of solving a specific problem which has emerged from class discussion.

The experiment itself should be co-operative. Whenever possible the class should have a part in the assembling and use of the apparatus. From the results of experiments a general conclusion should be deduced and its application developed.

The subject matter of the syllabus has been arranged so as to adhere as far as possible to the natural division into biology on the one hand and the closely related sciences of physics and chemistry on the other. Indeed the Ontario climate practically forces such an arrangement on the teacher, even if he were inclined to break through the boundaries between the special sciences. It is recognized, however, that the details of content given below can be arranged in as many ways as there are teachers.

Some may wish to make greater use of the "unit" or "topical" plan than is suggested in the syllabus, feeling that such a method follows the growing interests of the pupils. The topics lend themselves to such a development.

A time allotment is given for each topic merely to indicate the "depth" of treatment intended. Some teachers may wish to treat certain topics more intensively than is suggested in the outline and may therefore not be able to cover all of the work in the time allowed. In order to give the teacher this latitude some topics have been marked as optional, but it is hoped that it may be found possible to include even these. In no case, however, should scientific methods of teaching be sacrificed to cover every detail of the course.

GENERAL SCIENCE, GRADE IX

OUTLINE OF THE COURSE

NOTE:—Topics marked with an asterisk (*) are optional.

Autumn and Early Winter

The relationship of plants to man. (One period.)

A preliminary discussion which will serve to arouse the pupils' interest in botany.

The living plant. (One period.)

Observation of the plant in its natural environment should precede classroom study. Variation in habit and the conditions (light and water) in which the plant grows should be noted.

The shoot and the root. (One period.)

The arrangement of leaves with relation to light; origin of flowers and branches from buds in the axils of leaves; general functions of flower, leaf, stem and root.

The parts of a flower and their functions. (Six periods.)

The shape and arrangement of the parts of two simple flowers, one with separate petals (e.g., buttercup, mustard), one with united petals (e.g., toad-flax, petunia).

Recognition that a composite flower is a group of florets, each with united petals.

A hand lens and a needle should be used in examining the stamens, pollen grains, pistil and ovules (The use of scientific terms in reference to the relationship of parts is not expected.)

Pollination and fertilization. (Four periods.)

Insect pollination and wind pollination; floral structure, nectar, abundance of pollen, colour, odour, etc.

Examination of the bee to discover adaptations for the collection of pollen and nectar.

Simple explanation of fertilization.

Fruit and seed. (Six periods.)

A study of the bean fruit, including seed, to show the parts, their origin and their relationship to other parts of the plant and to the propagation of the plant.

A study of simple fleshy fruits such as the tomato, plum and apple. (Classification not expected.)

Adaptations of plants for fruit and seed dispersal.

Weeds. (Two periods.)

Recognition of at least ten common weeds mentioned in The Weed Control Act; sight identification of these should be acquired by field trips or study of specimens collected by the pupils.

Winter

Preliminary discussion of relation of water to plant and animal life. (Two periods.)

Widespread distribution of water.

Experiment to show water in plant tissue and in animal tissue.

Water as necessary to plant and animal life.

Water as a habitat for plants and animals.

Brief discussion of water conservation.

Water in various states. (Four periods.)

Solids, liquids, gases.

Freezing of water, melting of ice and snow.

Observation of snow crystals or other crystals grown by the class as a home assignment.

Experiment to show steam from boiling water and condensation on a colder surface.

Experiment to show evaporation of water.

Formation of dew.

* Frosting of windows and appearance of hoar (white) frost to illustrate sublimation.

* Experiment to show sublimation with benzoic acid.

Importance of water as a solid. (One period.)

Value of snow as a protecting cover for plants and as a means of water storage in nature.

Experiment to show expansion of water on freezing, as a home assignment; application to floating of ice and to disintegration of rocks and formation of soil.

Importance of water as a gas. (Two periods.)

Experiment to show presence of water vapour in the atmosphere.

Experiment to show great expansion of water on vaporization; reference to the steam engine.

Water as a solvent. (Four periods.)

Distilled and ordinary water; an experimental illustration of the separation of water and dissolved solids by distillation.

Solution: experimental illustration of the relative solubility of solids.

* Saturated solutions.

The dissolving of air in water and its significance to aquatic life.

The cause of hardness in water.

An experimental illustration of the behaviour of hard water with soap.

Thermometers. (Three periods.)

Thermal expansion of matter in each of its three states.

Experiment to show thermal expansion of liquids.

Thermal expansion of liquids as a means of measuring change in temperature.

Use of freezing point and boiling point of water as fixed points in establishing a thermometric scale.

Compare Fahrenheit and Centigrade scales by reading temperatures in both scales.

Compare alcohol and mercury thermometers.

Clinical thermometers.

Practice in measurement with metric units. (Four periods.)

Measurement of length in metres, centimetres, and millimetres; comparison of the kilometre and the mile.

The measurement of the area of a rectangular card and of the volume of a rectangular solid.

The measurement of the volume of a liquid.

* Proper use and care of the balance.

Measurement of the mass of a solid by use of a balance.

Density. (Two periods.)

Meaning.

Density of the solid used above.

Experimental determination of density of water.

Importance in nature of maximum density of water.

* Experimental demonstration of density of mercury.

Municipal water supply. (Three periods.)

How water is brought to the home from its source.

An elementary study of the supply, purification and use of water in an urban or rural municipality.

* Sand filtration:

(a) Clarification: the effect upon the grains of sand in the bed of adding aluminium sulphate (filter alum).

An experimental illustration of the clarification of a clay suspension: the explanation not to involve chemical formulae.

(b) Detention of bacteria; reference to harmful bacteria.

* Chlorination: an explanation of its purpose (not to involve chemical formulae).

Pressure in liquids. (Two periods.)

Experiment to show that water exerts pressure.

Experiment to show that the pressure varies with the depth.

Experiment to show that the pressure is equal in all directions.

Recognition that the weight of a body is a force and that the pressure is due to weight.

The composition of water. (One period.)

* The analysis of water by electrolysis to show that it is composed of two gases identified as oxygen and hydrogen.

The composition of air. (Four periods.)

An experiment to show the rusting of iron in damp air; the properties and identity of the fraction of air removed and the fraction remaining.

Experimental illustration that atmospheric oxygen is necessary for combustion.

Experimental illustration of the production of carbon dioxide by (a) combustion of charcoal (carbon) in air, (b) respiration.

Demonstration of such properties of carbon dioxide as density, and effect upon a flame.

Importance of air. (One period.)

The atmosphere.

Air in soil.

Air in water.

The resistance of air to moving bodies.

Air pressure. (Three periods.)

Experiments to show that air occupies space and that air has weight.

Experiment to show that air exerts pressure.

Utilization of air pressure as shown in such devices as fountain pen, common water pump, and siphon (mechanical details of these not expected).

Measurement of atmospheric pressure. (Three periods.)

Construction of the mercury barometer.

Variation from day to day and from place to place.

* The height of a water barometer.

Observation of the aneroid barometer with practice in making readings.

Its use to measure altitude shown by taking readings at different levels.

Compression and expansion of gases. (Two periods.)

Experimental demonstration.

Elementary discussion of the relationship of volume and pressure.

Compression of air in the bicycle or automobile tire, air pump, air gun, air tools, sand blast (mechanical details not required).

Convection in liquids. (Two periods.)

Thermal expansion.

Experiment to show convection currents in water.

Hot-water heating system (simple notion of circulation only).

Convection in gases. (Three periods.)

Experiment to show convection in air.

Air movement as illustrated in a hot-air heating system, in a heated room, and in a refrigerator; draught in a chimney.

Importance of ventilation.

Effects of water in motion. (One period.)

Rain wash.

River erosion.

Wave erosion.

Deposition of sediment.

Effects of air in motion. (Two periods.)

Sailing ships, windmills.

Soil drifting.

Sand dunes.

Rainfall and wind.

The work of the Meteorological Service. (Three periods.)

Isobars.

Relation of winds to isobars.

Weather maps.

High-pressure and low-pressure areas with their winds and weather.

Spring and Early Summer

Structure and function of the leaf. (Nine periods.)

Examination of leaf epidermis, including stomata.

Examination of a cross-section of a leaf to show arrangement of the cells and cell structure.

Experiment to show the iodine test for starch.

Experiment to show that starch is made in green leaves in the light and disappears in the dark.

Experiment to show the presence of starch in seeds and tubers, etc.

The use of an aquatic green plant to show the exhalation of oxygen in bright light; the need for carbon dioxide in the process, e.g., comparison of effect with (a) boiled water, (b) boiled water with carbon dioxide added.

Experiment to show transpiration in green plants.

Growth, structure, and function of the stem. (Four periods.)

A study, over a period of time, of a growing bean plant or of green twigs with opening buds to show the increase in length due to primary growth at or near the tip.

Examination of a green twig to show (a) the location and nature of the cambium layer, (b) that in the older part of the twig there is a greater thickness due to the activity of the cambium (secondary growth).

Examination of a cross-section of oak or other tree trunk to discover: pith, heart-wood, sap-wood, rays, cambium, outer and inner bark.

Demonstration of the rise of water in stems.

Absorption by roots. (Five periods.)

Experiment to show the presence of mineral salts in solution in soil water.

Observation of the development of root hairs in germinating seeds.

* Demonstration of diffusion of a gas in air and of a dissolved salt in water.

Simple experiments illustrating the absorption of water with salts in solution through membranes and the significance of this in absorption by roots.

Plant propagation, practical application. (Five periods.)

Means of controlling transpiration in the transplanting of seedlings, shrubs, trees.

* Vegetative reproduction as shown in the growing of strawberry, potato, raspberry, geranium (from slips), etc.

Pruning of trees; removal of buds and its effect on the growth of the plant.

* Grafting and budding in trees and shrubs.

REFERENCE BOOKS

General Science, Book I . . . . . J. M. Dent & Sons Ltd.
A Junior Science for Secondary Schools, Part I . . Sir Isaac Pitman & Sons Ltd.
Elements of Physics . . . . . The Copp Clark Co. Ltd.
Chemistry for High Schools . . . . . W. J. Gage & Co.
Chemistry Manual . . . . . W. J. Gage & Co.
Everyday Problems in Science . . . . . W. J. Gage & Co.
Science in Daily Life . . . . . Longmans, Green & Co.
A Book of General Science . . . . . The Macmillan Co. Ltd.
The World of Science . . . . . The Ryerson Press

AGRICULTURAL SCIENCE

Objectives

(a) To develop an understanding and appreciation of the materials and natural phenomena in the pupils' environment;
(b) to develop a scientific interest in the problems and activities of rural life;
(c) to cultivate the pupils' powers of discriminating observation, critical thinking, accurate expression and relating cause and effect;
(d) to correlate the activities of school work with those of the farm and community.

The method of instruction should provide definite pupil activity in the examining of materials, performing experiments and in outdoor practical work. The project method should have a definite place in the teaching. Every pupil must complete a home project on a suitable topic approved by the teacher as a part of the work of Grades IX and X. This project should be selected in Grade IX.

Well supervised notebook work plays an important part in the training. The notebook should contain a neat and accurate record of the pupil's work, illustrated by suitable diagrams or pictures. These records should be a clear expression of the impressions gained from investigations and discussions.

A time allotment is given for each topic merely to indicate the "depth" of treatment intended. Teachers are expected to use discretion in the emphasis given to different topics and should not greatly exceed the time allotment suggested. In case some teachers have not sufficient time to cover the whole course, the topics which are marked optional may be omitted.

AGRICULTURAL SCIENCE, GRADE IX

OUTLINE OF THE COURSE

NOTE:—Topics marked with an asterisk (*) are optional.

Autumn and Early Winter

The relationship of plants to man. (One period.)	A preliminary discussion which will serve to arouse the pupils' interest in plants and their relation to agriculture.
Gardening and weed study. (Two periods.)	Autumn care of the garden; recognition of at least ten weeds mentioned in The Weed Control Act.
The living plant. (One period.)	Observation of the plant in its natural environment should precede classroom study. Variation in habit and the conditions (light and water) under which the plant grows should be noted.
The shoot and the root. (One period.)	The arrangement of leaves with relation to light; origin of flowers and branches from buds in the axils of leaves; general functions of flower, leaf, stem and root.
The parts of a flower and their functions. (Six periods.)	The shape and arrangement of the parts of two simple flowers, one with separate petals (e.g., buttercup, mustard), one with united petals (e.g., toad-flax, petunia). Recognition that a composite flower is a group of florets, each with united petals. A hand lens and a needle should be used in examining the stamens, pollen grains, pistil and ovules. (The use of scientific terms in reference to the relationship of parts is not expected.)

Pollination and fertilization. (Four periods.)

Insect pollination and wind pollination; floral structure, nectar, abundance of pollen, colour, odour, etc.

Examination of the bee to discover adaptations for the collection of pollen and nectar.

Simple explanation of fertilization.

Fruit and seed. (Six periods.)

A study of the bean fruit, including seed, to show the parts, their origin and their relationship to other parts of the plant and to the propagation of the plant.

A study of simple fleshy fruits such as the tomato, plum and apple. (Classification not expected.)

Adaptation of plants for fruit and seed dispersal.

Composition, use and care of milk. (Seven periods.)

Composition of whole milk; milk as a complete food; examination of a drop of milk under the compound microscope to observe the fat globules; testing whole milk with the Babcock tester; value of this test in keeping individual cow records and as a basis of payment for milk; care of milk on the farm.

Winter and Early Spring

Preliminary discussion of relation of water to plant and animal life. (Two periods.)

Widespread distribution of water.

Experiment to show water in plant tissue and in animal tissue.

Water as necessary to plant and animal life.

Water as a habitat for plants and animals.

Brief discussion of water conservation.

Water in various states. (Four periods.)

Solids, liquids, gases.

Freezing of water, melting of ice and snow.

Observation of snow crystals or other crystals grown by the class as a home assignment.

Experiment to show steam from boiling water and condensation on a cold surface.

Experiment to show evaporation of water.

Formation of dew.

* Frosting of windows and appearance of hoar (white) frost to illustrate sublimation.

* Experiment to show sublimation with benzoic acid.

Importance of water as a solid. (One period.)

Value of snow as a protecting cover for plants and as a means of water storage in nature.

Experiment to show expansion of water on freezing, as a home assignment; application to floating of ice and to disintegration of rocks and formation of soil.

Importance of water as a gas. (Two periods.)	Experiment to show presence of water vapour in the atmosphere.
	Experiment to show great expansion of water on vaporization; reference to the steam engine.
Water as a solvent. (Four periods.)	Distilled and ordinary water; an experimental illustration of the separation of water and dissolved solids by distillation.
	Solution: experimental illustration of the relative solubility of solids.
	* Saturated solutions.
	The dissolving of air in water and its significance to aquatic life.
	The cause of hardness in water.
	An experimental illustration of the behaviour of hard water with soap.
Thermometers. (Three periods.)	Recall thermal expansion of matter in each of its three states.
	Experiment to show thermal expansion of liquids.
	Thermal expansion of liquids as a means of measuring change in temperature.
	Use of freezing point and boiling point of water as fixed points in establishing a thermometric scale.
	Compare Fahrenheit and Centigrade scales by reading temperatures in both scales.
	Compare alcohol and mercury thermometers.
	Clinical thermometers.
	Dairy or hot-bed thermometer.
Practice in measurement with metric units. (Four periods.)	Measurement of length in metres, centimetres, and millimetres; comparison of the kilometre and the mile.
	The measurement of the area of a rectangular card and of the volume of a rectangular solid.
	The measurement of the volume of a liquid.
	* Proper use and care of the balance.
	Measurement of the mass of a solid by use of a balance.
Density. (Two periods.)	Meaning.
	Density of the solid used above.
	Experimental determination of density of water.
	Importance in nature of maximum density of water.
	* Experimental demonstration of density of mercury.
Farm water supply. (Four periods.)	Source; protection from pollution.
	Purification of water by boiling; use of chloride of lime.

Pressure in liquids. (Two periods.)

Experiment to show that water exerts pressure.

Experiment to show that the pressure varies with the depth.

Experiment to show that the pressure is equal in all directions.

Recognition that the weight of a body is a force and that the pressure is due to weight.

The composition of water. (Three periods.)

* The analysis of water by electrolysis to show that it is composed of two gases identified as oxygen and hydrogen.

The composition of air. (Four periods.)

An experiment to show the rusting of iron in damp air; the properties and identity of the fraction of air removed and the fraction remaining.

Experimental illustration that atmospheric oxygen is necessary for combustion.

Experimental illustration of the production of carbon dioxide by (a) combustion of charcoal (carbon) in air, (b) respiration.

Demonstration of such properties of carbon dioxide as density, and effect upon a flame.

Importance of air. (One period.)

The atmosphere.

Air in soil: increase by cultivation and under-drainage.

The resistance of air to moving bodies.

Air pressure. (Three periods.)

Experiments to show that air occupies space and that air has weight.

Experiment to show that air exerts pressure.

Utilization of air pressure as shown in such devices as fountain pen, common water pump, and siphon (mechanical details of these not expected).

Measurement of atmospheric pressure. (Three periods.)

Construction of the mercury barometer: how it works.

Variation from day to day and from place to place.

* The height of a water barometer.

Observation of the aneroid barometer with practice in taking readings.

Its use to measure altitude shown by taking readings at different levels.

Compression and expansion of gases. (Two periods.)

Experimental demonstration of the compression and expansion of air.

Elementary discussion of the relationship of volume and pressure.

Compression of air in the bicycle or automobile tire, air pump, air gun, air tools, sand blast (mechanical details not required).

Convection in liquids. (Two periods.)	Thermal expansion. Experiment to show convection currents in water. Hot-water heating system or the hot-water incubator (simple notion of circulation only).
Convection in gases. (Three periods.)	Experiment to show convection in air. Air movement as illustrated in a hot-air heating system, in a heated room, and in a refrigerator; draught in a chimney. Importance of ventilation.
Effects of water in motion. (One period.)	Rain wash and how it is combated on farm lands. River erosion. Wave erosion. Deposition of sediment.
Effects of air in motion. (Two periods.)	Sailing ships, windmills. Soil drifting; how checked. Sand dunes. Rainfall and wind.
The work of the Meteorological Service. (Three periods.)	Isobars. Relation of winds to isobars. Weather maps. High-pressure and low-pressure areas with their winds and weather.
Breeds, incubation and management of chickens. (Ten periods.)	Recognition of at least six breeds of chickens kept in the locality; characteristics of the class to which they belong; hatching of chicks in the school incubator; brooding and rearing of chicks; housing and management of chickens; care of eggs.

Spring and Early Summer

Structure and function of the leaf. (Nine periods.)	Examination of leaf epidermis, including stomata. Examination of a cross-section of a leaf to show arrangement of the cells and cell structure. Experiment to show the iodine test for starch. Experiment to show that starch is made in green leaves in the light and disappears in the dark. Experiment to show the presence of starch in seeds and tubers, etc. The use of an aquatic green plant to show the exhalation of oxygen in bright light; the need for carbon dioxide in the process, e.g., comparison of effect with (a) boiled water, (b) boiled water with carbon dioxide added. Experiment to show transpiration in green plants.
Growth, structure and function of the stem. (Four periods.)	A study, over a period of time, of a growing bean plant or of green twigs to show the increase in length due to primary growth at or near the tip.

Examination of a green twig to show (a) the location and nature of the cambium layer, (b) that in the older part of the twig there is a greater thickness due to the activity of the cambium (secondary growth).

Examination of a cross-section of oak or other tree trunk to discover: pith, heart-wood, sap-wood, rays, cambium, outer and inner bark.

Demonstration of the rise of water in stems.

Absorption by roots. (Five periods.)

Experiment to show the presence of mineral salts in solution in soil water.

Observation of the development of root hairs in germinating seeds.

* Demonstration of diffusion of a gas in air and of a dissolved salt in a liquid.

Simple experiments illustrating the absorption of water with salts in solution through membranes and the significance of this in absorption by roots.

Methods and practice of gardening. (Five periods.)

Planning and preparation of the school or home garden.

Preparation, care and uses of the hotbed and cold frame.

Methods of growing early vegetables such as potatoes, onions, rhubarb, lettuce, cabbage, tomatoes.

Methods of growing annual and perennial flowers.

REFERENCE BOOKS

The reference books listed for the course in General Science should be used for the corresponding topics in Agricultural Science. The following are recommended for other topics:

Dairying, Farm and Factory. Dean.....The Ryerson Press, Toronto

Poultry Production. Lippincott and Card (Fifth Edition).....
Lea & Febiger, Philadelphia

The Garden Guide.....The General Publishing Co., Toronto

Bulletins of the Ontario Department of Agriculture, Toronto, and the Dominion Department of Agriculture, Ottawa.

SUGGESTED EXPERIMENTS IN GENERAL SCIENCE AND AGRICULTURAL SCIENCE

GRADE IX

Display specimens of shoots containing green tissues may be prepared by colour fixation. To a saturated solution of copper acetate in 50% acetic acid add an equal quantity of water. Heat to boiling and immerse specimens until green colour, which is lost at first, returns. Wash the specimens in water. Keep the fixing solution for future use. Preserve specimens in 5% commercial formalin in flat-sided jam bottles. Seal by pouring melted paraffin into the cover and screwing the cover on while the wax is setting.

This procedure is suitable for demonstrating leaf arrangement, inflorescence, small flowers, barberry leaves infected with wheat rust, mosses, etc., when fresh material is not available.

Transpiration:

Exp. 4, page 91, of the High School Botany—**or** use a single leaf, still attached to the plant. Slide the petiole into a slit cut in a piece of cardboard. Support the cardboard on a retort-stand ring. Cover the leaf with an inverted beaker.

The rise of water in a stem:

Exps. 1, 2 and 3, pages 105–6, High School Botany.

Mineral salts in soil water:

This may be demonstrated by placing a small amount of soil in some water in a bottle. After shaking the mixture well, filter and evaporate to dryness some of the filtrate.

Root hairs:

Exp. 8, page 123, High School Botany—**or** red-top grass seed placed on thin agar solution in a covered Petri dish or a saucer covered with a piece of glass will develop root hairs in about three days.

Diffusion of a gas in air:

Use perfume or ammonia.

Diffusion of a salt in a liquid:

Exp. IX, No. 3, Chemistry Manual.

Absorption of water and mineral salts:

Exp. I, page 120, High School Botany.

Fruit and seed:

The structure of the seed may be studied from the ripened bean in place of the immature seed in the pod.

Examination of leaf epidermis:

Exp. 6, page 91, High School Botany.

Suggested Experiments, Grade IX

Test for starch:

Exp. 6, page 76, High School Botany.

Starch in green leaves:

Exps. 1 and 2, page 90, High School Botany.

Place the leaf in boiling water for a few minutes to kill the cells and promote permeability before putting it in the alcohol. Do not place the alcohol directly over a flame, but in a water bath after the flame has been removed.

Starch in seeds:

Exp. 7, page 76, and Exp. 4, page 106, High School Botany.

Oxygen given off by green leaves:

Exp. 3, page 90, High School Botany.

The purpose of boiling the water is to drive off dissolved nitrogen. As the boiling, however, drives off the carbon dioxide also, more carbon dioxide must then be put into the water. This may be done by adding half a teaspoonful of baking soda to each litre of water.

Crystallization:

Crystals of salt, sugar, alum, bluestone, etc., may be grown at room temperature by the complete evaporation of the decanted solution of each on a flat glass surface or by the evaporation of a solution in which a string is suspended

Sublimation of benzoic acid:

Exp. V, page 2, Chemistry Manual.

Presence of water vapour in the atmosphere:

This may be demonstrated by bringing a pitcher of cold water, with ice added if necessary, into a warm room.

Expansion of water on vaporization:

Put a little water into a florence flask. Cover the flask with a watch-glass; then heat the flask, allowing the water to boil. Note the motion of the watch-glass.

Distillation of water:

Fig. 13, Chemistry Manual, for apparatus. Add some common salt and a little potassium permanganate or other colouring matter to the water before boiling.

Relative solubility of solids:

Use three test-tubes of the same size. Place, to a depth of 3 cm., in one, hypo (sodium thiosulphate), in another, common salt, and in the third, powdered blackboard chalk. To each of these add water to a depth of 3 cm. (measured in another test-tube). Shake and observe the amount of solid remaining in each case.

Behaviour of hard water with soap:

In each of two test-tubes place distilled water (or rain water) to a depth of 3 cm. To one add a small piece (about the size of a pinhead) of calcium chloride. To each add a few drops of soap solution and shake. Directions for making soap solution are given on page 97 of the Chemistry Manual.

Suggested Experiments, Grade IX

Rapid sand filtration:

In each of two clear glass bottles place 100 c.c. of water and to each add a small lump of clay. Shake each bottle and to one add about 5 c.c. of lime-water and about 10 c.c. of a saturated solution of aluminium sulphate (filter alum) or common alum. Allow the bottles to stand undisturbed.

Electrolysis of water:

Part of the experiment described on page 68 of the Chemistry Manual.

Rusting of iron in damp air:

Exercise XVI, Chemistry Manual.

Oxygen necessary for combustion:

Exercise XVI, Chemistry Manual.

Production of carbon dioxide:

(a) Exercise XVII, Chemistry Manual.
Use air instead of oxygen.

(b) Exhale breath from the lungs through lime-water.

Density of carbon dioxide; effect of carbon dioxide on a flame:

Exercise XXXIV, Chemistry Manual.

Thermal expansion of liquids:

Section 229, Elements of Physics.

Measurement:

It is suggested that cards of different areas and solids of different volumes should be prepared in sufficient number for individual use. Each card should be numbered and the results checked.

Density of water:

Weigh a dry beaker. To it add a volume of water measured by means of a pipette and re-weigh.

Density of mercury:

Since a pipette cannot be used with mercury, the volume must be measured in a graduated cylinder.

Pressure in liquids:

In a tall tin can punch a series of holes in a vertical line and several holes at one level. This may be assigned as a home project to show all three experiments outlined in the Course.

Air pressure:

Simple experiments are suggested, such as those with the Magdeburg hemispheres, card over inverted tumbler full of water, collapse of a varnish tin filled with steam, stoppered, etc. Section 97, Elements of Physics.

Compression and expansion of gases:

Close the outlet of a bicycle pump, push down the piston, then let go.

Remove the air from a bell-jar in which there has been placed a toy balloon slightly inflated. Fig. 124, Elements of Physics.

GENERAL SCIENCE, GRADE X

OUTLINE OF THE COURSE

NOTE:—Topics marked with an asterisk (*) are optional.

Fundamental functions of plants and animals. (One period.)

Manufacture of food by plants; dependence of animals on plants for food and oxygen; use by plants of carbon dioxide produced by animals.

Animals in relation to man's interests. (Two periods.)

Various forms of animal life; domesticated animals; value of wild animals. Reference to economic importance of insects.

Insects

Habits, structure and life history. (Ten periods.)

A study of the living grasshopper; its habits (breathing, locomotion, feeding, etc.).

A study of the main external features of the grasshopper to show its fitness for its mode of life. Life history of the grasshopper.

* A study of at least two other insects to show variation in external features, feeding habits and life histories (classification not required).

General characteristics of insects; rate of reproduction; natural control factors.

Harmful and beneficial insects. (Five periods.)

A brief survey of insects injurious to plants, to animals, to household goods, and to man; nature of injury and methods of control.

* A brief survey of beneficial insects as scavengers, predators, pollinators, etc.

Social insects. (Five periods.)

A study of the life history, habits and economic importance of the honey bee.

* A brief survey of other social insects.

Fungi

Bread mould. (Two periods.)

Culture of bread mould and microscopic examination of the mycelium, sporangium and spores.

Mushroom. (Two periods.)

The mushroom as a plant: vegetative and reproductive parts; mode of life; recognition of the common meadow mushroom and of the poisonous Amanita.

Yeast. (Two periods.)

Culture of yeast in sugar solution and collection and identification of carbon dioxide; microscopic examination of yeast cells; economic importance.

Parasitic fungi. (Three periods.)

A brief discussion of the widespread occurrence of blights, mildews, smuts, rusts, etc., and the injury they do to plants of economic importance.

* Recognition of one parasitic fungus and a study of its mode of life; methods of control; the role of fungicides.

Bacteria. (Five periods.)

What they are and where they occur; beneficial and harmful kinds; laboratory demonstration by the use of Petri dishes and agar to show development of colonies of bacteria;

experiments to show (1) pasteurization of milk, (2) sterilization of milk and of canned foods; water pollution; purification of water by boiling; use of chloride of lime as a disinfecting agent; infectious diseases, e.g., tuberculosis, typhoid fever, diphtheria; discussion of agents of infection, such as house flies, drinking cups, etc.

The Heavens

(Eight periods.) Instructions for the following observations should be given at the opening of school in September.

The sun. Observation of the position of the sun (1) at different times of a single day, (2) at noon from week to week, (3) at sunrise and sunset from week to week; observation of the variation in the length and direction of shadow in (1) and (2).

The moon. Observation of the position of the moon at different hours of a single evening; observation of its position and appearance at the same hour for successive evenings.

* Observation of the position of the full moon at rising and of the elevation of its path above the southern horizon at various seasons of the year.

The stars. Observation of the position of the Great Dipper (1) at different hours in the same evening, (2) at the same hour in successive months; recognition of at least three other constellations; recognition of the Milky Way; observation of the position of the polar star.

* Recognition of at least three stars of first magnitude.

Planets. Recognition of two planets and observation of the change in position of one of them; observation with field glasses or opera glasses of four of the moons of Jupiter.

Meteors. Report of meteors observed during school year, with special attention to meteoric showers occurring in October, November, December and April.

NOTE:—It is assumed that a total of eight periods during the school year will be required for the discussion of above observations.

Movements and distances of the heavenly bodies. (Two periods.) The diurnal rotation of the earth; the annual revolution of the earth; the revolution of the moon about the earth; the rotation of the moon on its axis.

The solar system: explanation of apparent movements of heavenly bodies; distance relations of sun, moon, planets, stars.

The meaning of light year.

Shadows and eclipses. (Three periods.) Rectilineal propagation of light: an experiment to show the formation of shadows (umbra and penumbra); explanation of solar and lunar eclipses.

Luminosity of heavenly bodies. (Three periods.)

* Luminous and non-luminous bodies; difference between diffuse and regular reflection; explanation of luminosity of the moon, of the planets and of meteors; explanation of the appearance of the moon at different phases.

General Science, Grade X

Energy

Heat units. (Four periods.)

Comparison of Fahrenheit and Centigrade scales by means of a graph.

An experiment to illustrate the meaning of quantity of heat; the distinction between quantity of heat and temperature; the calorie and the British thermal unit.

An experiment to show that different substances have different heat capacities; the importance of the high heat capacity of water in relation to climate.

Change of state. (Four periods.)

Experiments to show absorption of heat without change in temperature when ice melts and when water boils; the use of ice in refrigerating and of steam in heating.

An experiment to show cooling by evaporation; the principle of artificial refrigeration.

* A brief explanation of evaporation in terms of molecular motion.

Hygrometry. (Four periods.)

Recall the presence of water vapour in the air.

An experiment to determine dew-point.

Meaning of relative humidity; measurement of the relative humidity of the air in the classroom by means of the wet and dry bulb hygrometer and of the hair hygrometer.

Humidifiers; the meaning of air-conditioning.

Force and weight. (Three periods.)

Recall that the pressure of a liquid is due to weight (a force).

Consideration of other types of force such as muscular exertion, tension in a cord, friction, elasticity of a spring.

Demonstration of the measurement of force by the extension of a spring; the weight or pull of the earth on a mass of one pound or one gram as a unit of force; the spring balance.

The use of the units of weight for the measurement of non-gravitational forces.

Work, energy and power. (Nine periods.)

Simple experiment with the lever and the single fixed pulley to show the relation between force and load; the use of those machines to explain the meaning of work; the foot-pound as a unit of work.

The meaning of energy; a simple discussion of the various common forms of energy; kinetic and potential energy.

Illustrations of transformations of energy and the law of conservation of energy.

Recall the transformation of radiant energy into chemical energy in the phenomenon of photosynthesis.

* A discussion of the role of friction, its advantages and disadvantages.

A brief discussion of the production of heat energy: by combustion (transformation of chemical potential energy); by compression (transformation of kinetic energy); by friction (transformation of kinetic energy); by the impact of a moving

body (quick transformation of kinetic energy); by an electric current (transformation of electrical energy); by the absorption of radiation (transformation of radiant energy).

Experiments to illustrate as many of these as possible.

An elementary consideration of the development of mechanical energy by (a) the transformation of heat energy, as in the steam engine, (b) the transformation of gravitational potential energy, as in the water turbine, (c) the transformation of chemical potential energy, as in the gasoline engine.

The meaning of power: the horse-power in foot-pounds per minute.

Magnetism and Electricity

Magnetism. (Four periods.)

An experiment to show magnetic poles by the attraction of iron filings to a bar magnet.

An experiment to show the position of rest of a suspended or pivoted magnet.

Experiments to show magnetic attraction and repulsion and to identify the poles of a magnet.

The earth as a magnet; the magnetic compass.

* An experiment to show magnetization of a knitting needle by stroking with a bar magnet (reference to the transformation of a part of the kinetic energy used in this process into magnetic potential energy).

Static electricity. (Two periods.)

Experiments to show the electrification of ebonite rubbed with fur and of glass rubbed with silk (reference to the transformation of a part of the kinetic energy used on this process into electrical potential energy).

An experiment to show electrical attraction and repulsion and to show the two kinds of electrification.

An experiment to identify several electrical conductors and non-conductors.

Current electricity. (Nine periods.)

An experiment to show the production of a current, indicated by sparks between the terminals of a static machine (transformation of mechanical into electrical energy).

An experiment to show the production and detection of a current from a voltaic cell (reference to a transformation of chemical energy into electrical energy).

The dry cell as a special form of the voltaic cell.

* Repeat the experiment on the electrolysis of water (reference to the transformation of electrical to chemical potential energy).

A brief discussion of the transformation of electrical energy into heat energy in the electric lamp, toaster, fuse, etc.

An elementary discussion of electrical units—volt, ampere, watt, kilowatt-hour—in relation to common electrical appliances and in payment for electrical energy; switches, fuses, short circuits, danger of "grounds" in household circuits.

Experiments to show the magnetic effect of an electric current (a) in the deflection of a compass needle, (b) in the electro-magnet.

Air

Composition of air. (Two periods.)

An experiment comparing the rusting of damp iron in air and in oxygen (obtained from cylinder or other source) showing (a) that oxygen is essential for the rusting of iron, (b) that oxygen is removed from air by this method, (c) that this experiment may be used to determine the approximate percentage by volume of oxygen and nitrogen in the air.

Combustion in oxygen and in air. (Five periods.)

* An experiment to show the combustion of iron in oxygen; comparison with the slow oxidation (rusting) of iron in air.

Experiments to show the combustion in oxygen of carbon (charcoal), sulphur, and magnesium; physical properties of the products.

Combustion of fuels: a chemical reaction (oxidation) producing heat energy; experiments to show by the production of carbon dioxide and water that fuels contain carbon and, in most cases, hydrogen; recall dripping of water from cold automobile exhaust pipes.

Discussion of the dangerous properties of combustible gases such as gasoline vapour, fuel oil vapour, and illuminating gas.

Protection from corrosion. (Two periods.)

(1) Surface coating: painting; galvanizing and tin-plating; electroplating (a simple experiment without theory).

* (2) Alloys: brief discussion of such non-corrosive alloys as stainless steel.

Carbon dioxide and weathering of rocks. (Four periods.)

An experiment to show (a) the solubility of carbon dioxide in water and (b) the effect of this solution on litmus. Compare the effect of other acids on litmus.

An experiment to show the action of a solution of carbon dioxide on a fine suspension of precipitated chalk in water; the application to the weathering of limestone.

Recall the hardness of water and, using the above solution, demonstrate (a) the cause of hardness of water, (b) the cause of deposition of scale in a kettle (due to loss of carbon dioxide).

Home and industrial uses of carbon dioxide. (One period.)

Its use in baking (obtained from baking soda and yeast).

Its use in carbonated beverages, fire extinguishers, and as dry ice.

The Composition and Classification of Foods

Water in foods. (Two periods.)

Experiments to show that foods contain water, and to show how the percentage of water may be determined in such foods as fresh vegetables, fresh fruits, cereals, butter.

Carbohydrates. (Four periods.)

An experiment to detect presence of starch in flour, potato, etc. An experiment to contrast sugar with starch in respect to solubility and taste. An experiment to show the presence in starch of (1) carbon, (2) hydrogen and oxygen (as shown by the condensation of water).

An experiment to show the conversion of starch to sugar (a) by the action of saliva, (b) by boiling with dilute hydrochloric acid. (Note change in appearance, action on hot Fehling's solution or Benedict's solution.)

Fats. (Two periods.)

Experiments to show that fats (1) are insoluble in water, (2) are soluble in carbon tetrachloride, (3) produce a persistent greasy translucent spot on paper.

An experiment to detect the presence of fat in butter, nuts, cheese, whole milk, etc.

Proteins. (Two periods.)

Proteins contain nitrogen in addition to carbon, hydrogen and oxygen. Many different proteins occur in the bodies of plants and animals as protoplasm and stored products.

Proteins vary greatly in some properties as shown in egg albumen, gluten, casein (cottage cheese) and milk albumen.

Experiments to show (1) that proteins are characterized by a disagreeable odour on charring, (2) the spot test with nitric acid and ammonium hydroxide.

Mineral salts. (Two periods.)

An experiment to show the presence of ash or mineral matter in such foods as rolled oats and potato, by gently burning to complete combustion.

The combustion of common foods. (Five periods.)

A discussion of the role of carbohydrates, proteins, fats, mineral salts and water in the diet, and the relative proportions of the food constituents as listed above in such common foods as flour, rice, beans, honey, butter, lard, salad oil, peanut butter, meat, eggs, fish, cheese.

Experiments to show that milk contains (a) water, (b) sugar, (c) fat, (d) casein and albumen, (e) mineral matter; the value of milk as a food.

The role of vitamins; the value of fresh foods and a varied diet.

Fuels and foods. (Four periods.)

* A comparison of the calorific value of various fuels.

An experiment to show the production of heat and the formation of carbon dioxide by the burning of sugar.

A discussion of food as fuel and of the calorie equivalent of some common foods. The role of food in supplying energy for heat and work.

Recall photosynthesis, stressing the absorption of energy in a reaction which is the reverse of the oxidation of carbon-containing substances.

A discussion of the carbon cycle.

General Science, Grade X

The Human Body

The cell. (Two periods.)

Recall the structure of a plant cell. Microscopic observation of a simple cell such as cheek epithelium to show cell wall, cytoplasm and nucleus; growth (a) by increase in size of cells, (b) by increase in the number of cells (cell division).

The cell as an organism with the functions of nutrition, motility and secretion. (If possible the living amoeba or paramoecium should be examined by the pupils.)

The meaning of tissues, organs, systems.

The skeleton and movement. (Four periods.)

The main features of the human skeleton (names required for the long limb bones only)

The relations of muscles, tendons, skeleton, and nerves in producing movement, e.g., the action of the biceps.

Simple reflexes such as the knee-jerk, and the reaction of the iris to light. Voluntary motion.

Digestion and absorption. (Two periods.)

The meaning of digestion; the alimentary canal; a brief discussion of digestive changes taking place in each of the parts; glands and juices taking part in these changes.

Absorption of digested food.

Circulation, respiration and excretion. (Seven periods.)

The blood and the lymph: observation of the circulation of blood in the web of a frog's foot or in a tadpole's tail; microscopic examination of a drop of blood diluted with physiological saline solution (0.9% common salt).

The constituents of the blood and their functions.

The circulation of the blood in the human body (names of arteries and veins not required); the changes taking place in the tissues, the kidneys and the lungs.

Protection from disease by the formation of antibodies.

An experiment to show that exhaled air contains more carbon dioxide than room air; the meaning of respiration (energy transformations).

The organs of breathing; the great surface area in the lungs; how breathing is carried on.

The danger of carbon monoxide poisoning.

* Reasons for ventilation.

The Aquarium and Aquatic Life

The fish. (Four periods.)

A study of the living fish: its habits (breathing, locomotion, feeding, etc.); a study of the main external features of the fish to show its fitness for its mode of life.

Life history and breeding habits of fishes (at least two examples).

* Fish conservation: preservation of conditions suitable for various kinds, fish hatcheries, reasons for fishing regulations.

The frog. (Three periods.)

A study of the living animal: its habits, external features, life history.

The economic importance of frogs and toads.

Other forms of aquatic animals.

Pupils should be encouraged to make careful observations of the activities of other animals, such as clams, crayfish, turtles, water beetles, water larvae, etc.

Inter-relationship. (One period.)

The interdependence of water plants and water animals should be emphasized: water plants are used as food by water animals; these plants give off oxygen, some of which is dissolved in water and is used by animals in respiration.

Water animals produce carbon dioxide which in turn is used by aquatic plants.

The making of a balanced aquarium.

Birds

External features and activities. (Four periods.)

Pupils should be encouraged to continue bird identification and bird watching throughout the year.

* A study of a few common birds to show general characteristics and variation in external features. The relation of birds to man; protection of birds.

Balance in Nature

(Three periods.)

Interdependence of plants and animals. If there is no interference with natural conditions there comes about an approximate equilibrium (determined by the climate) among plants, herbivores and carnivores. Dominant vegetation: deciduous forests in S. Ontario, conifers in N. Ontario. Man disturbs this equilibrium in the following ways: (1) drainage of swamps—effect on plants, birds, and aquatic animals; (2) removal of forests—effect on certain birds and mammals; (3) cultivation of the soil—effect on plants, soil, inhabiting organisms; (4) extermination of animals, e.g., passenger pigeon, buffalo; (5) introduction of new plants, purposely or accidentally—relation to insects and fungous diseases; (6) introduction of new animals, e.g., English sparrow, starling, European corn-borer, saw-fly, insect predators.

REFERENCE BOOKS

General Science, Book II.....J. M. Dent & Sons Ltd., Toronto
A Junior Science for Secondary Schools, Part II.....
Sir Isaac Pitman & Sons, Toronto
Elements of Physics.....The Copp Clark Co. Ltd., Toronto
Chemistry for High Schools.....W. J. Gage & Co., Toronto
Chemistry Manual.....W. J. Gage & Co., Toronto
Everyday Problems in Science.....W. J. Gage & Co., Toronto
Science in Daily Life.....Longmans, Green & Co., Toronto
A Book of General Science.....The Macmillan Co. Ltd., Toronto
The World of Science.....The Ryerson Press, Toronto

AGRICULTURAL SCIENCE, GRADE X

OUTLINE OF THE COURSE

NOTE:—Topics marked with an asterisk (*) are optional.

Preview of world's greatest industry. (One period.)

Compare the nature of early farming in Canada with that of today. Discuss (1) the necessity of scientific knowledge and practice in agriculture, (2) the dependence of other occupations on agriculture.

The five great plant groups of farm, garden and orchard. (One period.)

Observe important members of the five different farm and garden crops, namely grass, legume, root and tuber, fleshy fruit and leaf plants; recognition of habit of growth that makes each valuable.

Full care of garden. (Two periods.)

Recognition and destruction of weeds in the garden; harvesting, storage or disposal of crops; sowing of fall rye (or wheat) as a green manure crop; fall cultivation.

Plant propagation. (Five periods.)

Discussion and practical demonstration **in season** of the following: (a) vegetative reproduction as shown in the growing of strawberry, potato, raspberry, geranium (from slips or cuttings), (b) planting and pruning of trees and shrubs; grafting and budding of trees and shrubs; (c) methods of growing flowering bulbs for outdoor and indoor bloom.

NOTE:—Part of the above work will be taken in gardening periods in the spring.

Insects

Habits, structure and life history of the grasshopper. (Three periods.)

A study of the living grasshopper; its habits (breathing, locomotion, feeding, etc.).

A study of the main external features of the grasshopper to show its fitness for its mode of life. Life history of the grasshopper.

General characteristics of common orders of insects. (Four periods.)

A comparison of the mouth parts, wings and metamorphoses of insects belonging to each of the following orders: Orthoptera (e.g., grasshopper, cricket); Odonata (e.g., dragon fly, damsel fly); Hemiptera (e.g., squash bug, stink bug); Homoptera (e.g., aphids, cicada); Coleoptera (e.g., potato beetle, lady-bird beetle); Lepidoptera (e.g., cabbage butterfly, sphinx moth); Diptera (e.g., house fly, mosquito); Hymenoptera (e.g., ant, ichneumon fly).

Characteristics common to all insects: i.e., three pairs of legs, three parts to the body, the life history a metamorphosis; rate of reproduction of one or two common insects.

NOTE:—Collection by each pupil of one specimen of each of the above orders. This work should be assigned in June of the previous school year.

Harmful and beneficial insects. (Four periods.)

A brief survey of insects injurious to plants, to animals, to household goods and to man (at least two examples in each case); nature and extent of injury; natural control factors; man's control.

* A brief survey of beneficial insects as scavengers, predators, pollinators, etc.

Beekeeping. (Five periods.)

The bee as an example of a social insect: study of the queen, drone and worker; their development and activity in the colony; examination and uses of the parts of a Langstroth hive; seasonal care of bees; causes and control of swarming; nectar-producing plants.

Fungi

Bread mould. (Two periods.)

Culture of bread mould and microscopic examination of the mycelium, sporangium and spores.

Mushroom. (Two periods.)

The mushroom as a plant: vegetative and reproductive parts, mode of life; recognition of the common meadow mushroom and of the poisonous Amanita, the puff ball and the polypore.

Yeast. (Two periods.)

Culture of yeast in sugar solution and collection and identification of carbon dioxide; microscopic examination of yeast cells; economic importance.

Plant diseases. (Five periods.)

A brief discussion of the widespread occurrence of blights, mildews, smuts, rusts, etc., and the injury they do to plants of economic importance (at least one example of each to be observed).

Recognition and mode of life of three parasitic fungi causing any three of the following diseases: apple scab, potato scab, black knot, corn smut; methods of control; the role of fungicides.

Bacteria. (Five periods.)

What they are and where they occur; beneficial and harmful kinds; laboratory demonstration by the use of Petri dishes and agar to show development of colonies of bacteria; experiments to show (1) pasteurization of milk, (2) sterilization of milk and of canned foods; water pollution; purification of water by boiling; use of chloride of lime as a disinfecting agent; infectious diseases, e.g., tuberculosis, typhoid fever, diphtheria; duscussion of agents of infection, such as house flies, drinking cups, etc.

Live Stock

(Ten periods.)

Types and common breeds of cattle, of sheep, of swine, and breeds of draught horses. Explanation of the terms: pedigreed stock and grade stock; disadvantages of keeping scrub stock.

Energy

Heat units. (Four periods.)

Comparison of Fahrenheit and Centigrade scales by means of a graph.

An experiment to illustrate the meaning of quantity of heat; the distinction between quantity of heat and temperature; the calorie and the British thermal unit.

An experiment to show that different substances have different heat capacities; the importance of the high heat capacity of water in relation to climate.

Change of state. (Four periods.)

Experiments to show absorption of heat without change in temperature when ice melts and when water boils; the use of ice in refrigerating and of steam in heating.

An experiment to show cooling by evaporation; the principle of artificial refrigeration.

* A brief explanation of evaporation in terms of molecular motion.

Hygrometry. (Four periods.)

Recall presence of water vapour in the air.

An experiment to determine dew-point.

Meaning of relative humidity; measurement of the relative humidity of the air in the classroom by means of the wet and dry bulb hygrometer and of the hair hygrometer.

Humidifiers; the meaning of air-conditioning.

Force and weight. (Three periods.)

Recall that the pressure of a liquid is due to weight (a force).

Consideration of other types of force such as muscular exertion, tension in a cord, friction, elasticity of a spring.

Experimental measurement of force by the extension of a spring; the weight or pull of the earth on a mass of one pound or one gram as a unit of force; the spring balance.

The use of the units of weight for the measurement of non-gravitational forces.

Work, energy and power. (Nine periods.)

Simple experiments with the lever and the single fixed pulley to show the relation between force and load; applications in farm appliances; the use of these machines to explain the meaning of work; the foot-pound as a unit of work.

The meaning of energy; a simple discussion of the various common forms of energy; kinetic and potential energy.

Illustrations of transformations of energy and the law of conservation of energy.

Recall the transformation of radiant energy into chemical energy in the phenomenon of photosynthesis.

* A discussion of the role of friction, its advantages and disadvantages.

A brief discussion of the production of heat energy: by combustion (transformation of chemical potential energy); by compression (transformation of kinetic energy); by friction (transformation of kinetic energy); by the impact of a moving body (quick transformation of kinetic energy); by an electric current (transformation of electrical energy); by the absorption of radiation (transformation of radiant energy).

Experiments to illustrate as many of these as possible.

An elementary consideration of the development of mechanical energy by (a) the transformation of heat energy, as in the steam engine; (b) the transformation of gravitational

potential energy, as in the water turbine; (c) the transformation of chemical potential energy, as in the gasoline engine.

The meaning of power: the horse-power in foot-pounds per minute.

Magnetism and Electricity

Magnetism. (Four periods.)

A demonstration of magnetic poles by the attraction of iron filings to a bar magnet.

A demonstration of the position of rest of a suspended or pivoted magnet.

Experiments to show magnetic attraction and repulsion and to identify the poles of a magnet.

The earth a magnet; magnetic compass.

* An experiment to show magnetization of a knitting needle by stroking with a bar magnet (reference to the transformation of a part of the kinetic energy used in this process into magnetic potential energy).

Static electricity. (Two periods.)

Experiments to show the electrification of ebonite rubbed with fur and of glass rubbed with silk (reference to the transformation of a part of the kinetic energy used in this process into electrical potential energy).

An experiment to demonstrate electrical attraction and repulsion and to show the two kinds of electrification.

Current electricity. (Nine periods.)

An experiment to identify several electrical conductors and non-conductors.

An experiment to show the production of a current, indicated by sparks between the terminals of a static machine (transformation of mechanical into electrical energy).

An experiment to show the production and detection of a current from a voltaic cell (reference to a transformation of chemical energy into electrical energy).

The dry cell as a special form of the voltaic cell.

* Repeat the experiment on the electrolysis of water (reference to the transformation of electrical to chemical potential energy).

A brief discussion of the transformation of electrical energy into heat energy in the electric lamp, toaster, fuse, etc.

An elementary discussion of electrical units—volt, ampere, watt, kilowatt-hour—in relation to common electrical appliances and in payment for electrical energy.

Switches, fuses, short circuits, danger of "grounds" in household circuits.

Experiments to show the magnetic effect of an electric current (a) in the deflection of a compass needle, (b) in the electro-magnet.

Soils

Collection and storage of soil samples. (One period.)

Collection of three or four different kinds of soil early in the fall for winter study.

Origin and formation of soils. (Two periods.)

Discussion of the origin of soils; the part of physical and chemical agencies in formation of soil; an experiment to show the physical composition of a loamy soil; classification of soils according to size of particles.

Properties of soil. (Three periods.)

Discuss meaning of light and heavy soils; test samples for degree of stickiness when wet and condition upon drying.

An experiment to show the relation of soil moisture to soil temperature.

An experiment to show the relation of soil colour to (1) soil temperature, (2) plant growth.

An experiment to test the effect of freezing and thawing upon soil granulation; reference to illustration in fall ploughing.

Soil moisture. (Five periods.)

Experiments to show the nature of (1) gravitational water, (2) capillary water, (3) hygroscopic water.

An experiment to compare the water-holding capacity and rapidity of percolation in dry sand, clay, and muck or rich loam.

An experiment to show how soil moisture may be conserved by a mulch; discussion of the application to farming and gardening.

An experiment to show soil porosity and the presence of soil air in loamy soil; discussion of the importance of air in soil for germination of seeds, the growth of roots, and the functioning of beneficial bacteria.

Recall experiment to show the presence of soluble matter in soil; discuss its relation to plant growth.

Organic matter in soils. (Two periods.)

Experiment to determine the relative amounts of organic matter in (1) loam, (2) clay, (3) sand, (4) muck.

Discuss the benefits of organic matter in soil and the role of soil bacteria.

Soil erosion and drifting. (One period.)

Discuss the causes of soil erosion and drifting and the means of prevention.

Air

Combustion in oxygen and in air. (Five periods.)

* An experiment to show the combustion of iron in oxygen; comparison with slow oxidation (rusting) of iron in air.

Experimental illustration of the combustion in oxygen of carbon (charcoal), sulphur, and magnesium; physical properties of the products and their solutions to identify acids and bases by their action on litmus paper.

Combustion of fuels: a chemical reaction (oxidation) producing heat and energy; experiments to show by the production of carbon dioxide and water that fuels contain carbon and hydrogen; recall dripping of water from cold automobile exhaust pipes.

Discussion of the dangerous properties of combustible fuels and gases such as gasoline vapour, fuel oil vapour and illuminating gas.

Protection from corrosion. (Two periods.)

(1) Surface coating: (a) use of paint and oil (care of farm machinery), (b) galvanizing and tin-plating, (c) electroplating (a simple experiment without theory).

* (2) Alloys: brief discussion of such non-corrosive alloys as stainless steel.

Carbon dioxide and weathering of rocks. (Five periods.)

An experiment to show (a) the solubility of carbon dioxide in water, (b) the effect of this solution on litmus.

Compare the effect of other acids on litmus.

A demonstration of the action of a solution of carbon dioxide on a fine suspension of precipitated chalk in water; the application to weathering of limestone.

Recall the hardness of water and, using the above solution, demonstrate (a) the cause of hardness of water, (b) the cause of deposition of scale in a kettle (due to loss of carbon dioxide).

Home and industrial uses of carbon dioxide. (One period.)

Its use in baking (obtained from baking soda and yeast).

Its use in carbonated beverages, fire extinguishers and dry ice.

Acidity and Fertility of Soils

Tests for acidity. (Four periods.)

Tests for acidity in soils: (1) litmus, (2) reacto-soil test; reference to the effect of soil acidity on plant growth; cause of soil acidity and the correction; drainage; adding lime.

The maintenance of fertility. (Four periods.)

The importance of the soil as a source of plant nutrients; recall the composition of air and water and discuss the components of soil.

A brief discussion of losses of plant nutrients from a soil by leaching and cropping.

Methods of replacing plant nutrients by (1) the use of barn-yard manure, (2) application of commercial fertilizers, (3) turning under of green crops (green manure).

Elementary discussion of the meaning and value of crop rotation.

The Composition and Classification of Foods

Water in foods. (Two periods.)

Experiments to show that foods contain water, and to show how the percentage of water may be determined in such foods as fresh vegetables, fresh fruits, cereals, butter.

Carbohydrates. (Four periods.)

An experiment to detect presence of starch in flour, potato, etc. An experiment to contrast sugar with starch in respect to solubility and taste. An experiment to show the presence in starch of (1) carbon, (2) hydrogen and oxygen (as shown by the condensation of water).

An experiment to show the conversion of starch to sugar (a) by the action of saliva, (b) by boiling with dilute hydrochloric acid. (Note change in appearance, action on hot Fehling's solution or Benedict's solution).

Fats. (Two periods.)

Experiments to show that fats (1) are insoluble in water, (2) are soluble in carbon tetrachloride, (3) produce a persistent greasy translucent spot on paper.

An experiment to detect the presence of fat in butter, nuts, cheese, whole milk, etc.

Proteins. (Two periods.)

Proteins contain nitrogen in addition to carbon, hydrogen and oxygen. Many different proteins occur in the bodies of plants and animals as protoplasm and stored products.

Proteins vary greatly in some properties as shown in egg albumen, gluten, casein (cottage cheese) and milk albumen.

Experiments to show that (1) proteins are characterized by a disagreeable odour on charring, (2) the spot test with nitric acid and ammonium hydroxide.

Mineral salts. (Two periods.)

An experiment to show the presence of ash or mineral matter in such foods as rolled oats and potato, by gently burning to complete combustion.

The combustion of common foods. (Five periods.)

A discussion of the role of carbohydrates, proteins, fats, mineral salts and water in the diet, and the relative proportions of the food constituents as listed above in such common foods as flour, rice, beans, honey, butter, lard, salad oil, peanut butter, meat, eggs, fish, cheese.

Recall experiments to show that milk contains (a) water, (b) sugar, (c) fat, (d) casein and albumen, (e) mineral matter; the value of milk as a food.

The role of vitamins; the value of fresh foods and a varied diet.

* A comparison of the calorific value of various fuels.

Fuels and foods. (Four periods.)

An experiment to show the production of heat and the formation of carbon dioxide by the burning of sugar.

A discussion of food as fuel and the calorie equivalent of some common foods. The role of food in supplying energy for heat and work.

Recall photosynthesis, stressing the absorption of energy in a reaction which is the reverse of the oxidation of carbon-containing substances.

A discussion of the carbon cycle.

Application to feeds for farm animals. (Two periods.)

Discussion of the importance of carbohydrates, fats, proteins, mineral matter in feeds for farm animals.

Distinction between roughage and concentrate feeds.

The Human Body

The cell. (Two periods.)

Recall the structure of a plant cell.

Microscopic observation of a simple cell such as cheek epithelium to show cell wall, cytoplasm and nucleus; growth (a) by increase in size of cells, (b) by increase in the number of cells (cell division).

The cell as an organism with the functions of nutrition, motility and secretion. (If possible the living amoeba or paramoecium should be examined by the pupils.)

The meaning of tissues, organs, systems.

The skeleton and movement. (Four periods.)

The main features of the human skeleton (names required for the long limb bones only).

The relations of muscles, tendons, skeleton, and nerves in producing movement, e.g., the action of the biceps.

Simple reflexes such as the knee-jerk, and the reaction of the iris to light. Voluntary motion.

Digestion and absorption. (Two periods.)

The meaning of digestion; the alimentary canal; a brief discussion of digestive changes taking place in each of the parts; glands and juices taking part in these changes.

Absorption of digested food.

Circulation, respiration and excretion. (Seven periods.)

The blood and the lymph: observation of the circulation of blood in the web of a frog's foot or in a tadpole's tail; microscopic examination of a drop of blood diluted with physiological saline solution (0.9% common salt).

The constituents of the blood and their functions.

The circulation of the blood in the human body (names of arteries and veins not required); the changes taking place in the tissues, the kidneys and the lungs.

Protection from disease by the formation of antibodies.

An experiment to show that exhaled air contains more carbon dioxide than room air; the meaning of respiration (energy transformations).

The organs of breathing; the great surface area in the lungs; how breathing is carried on.

The danger of carbon monoxide poisoning.

* Reasons for ventilation.

Comparison with domestic animals. (Two periods.)

A brief discussion of the skeletal structure, the digestive system, the circulatory system and the respiratory system of farm animals as illustrated in the horse and the cow.

Agricultural Science, Grade X

Birds

External features and activities. (Four periods.)

Pupils should be encouraged to continue bird identification and bird watching throughout the year.

* A study of a few common birds to show general characteristics and variation in external features. The relation of birds to agriculture; protection of birds.

Balance in Nature

(Three periods.)

Interdependence of plants and animals. If there is no interference with natural conditions there comes about an approximate equilibrium (determined by the climate) among plants, herbivores and carnivores. Dominant vegetation: deciduous forests in S. Ontario, conifers in N. Ontario. Man disturbs this equilibrium in the following ways: (1) drainage of swamps—effect on plants, birds, and aquatic animals; (2) removal of forests—effect on certain birds and mammals; (3) cultivation of the soil—effect on plants, soil, inhabiting organisms; (4) extermination of animals, e.g., passenger pigeon, buffalo; (5) introduction of new plants, purposely or accidentally—relation to insects and fungous diseases; (6) introduction of new animals, e.g., English sparrow, starling, European corn-borer, saw-fly, insect predators.

Methods and Practice in Gardening

(Eight periods.)

Planning, preparation and planting of plots of vegetables or farm crops in the home or school garden.

Discussion of methods of planting and care of fruit trees, bush fruits, flowering shrubs, annual and perennial flowering plants and **practice** in planting in the school garden; making and caring for a lawn.

Home Project Activities

Each pupil should complete at least one project before the end of the second year. In many cases the project may be commenced in Grade IX and completed in Grade X. The teacher should encourage selection of projects suited to the experience and ability of the pupil. Boys and girls from farm homes should select projects related to growing of crops and other farm activities. All projects should be supervised by the teacher and visits be made during the summer to homes where projects on growing crops or raising live stock are in progress. A suitable report should be required of all pupils.

The following is a suggested list of projects which can be varied and enlarged to suit local requirements:

1. Management of a home garden of flowers and vegetables.
2. Improvement of home grounds.
3. Construction and care of a hot-bed.
4. Management of a colony of bees.
5. Incubation and rearing chickens.
6. Crate-fattening of poultry.

7. Canning fruit or vegetables.
8. Growing plots of farm crops: grains, potatoes, root crops, tomatoes, etc.
9. Keeping a record of egg production and cost of feed for a flock for two or three months.
10. Keeping records of milk production from one or more cows for two or three months.
11. Keeping a record of feeding costs of farm animals.
12. Membership and activity in a Potato Club, Foal Club, Swine Club, Calf Club, Grain Club, or Home Canning Club.
13. Experiments to show the effect of the use of commercial fertilizers.
14. Collection of 100 insects.
15. Collection of 40 weeds and 6 grasses.
16. Collection of 20 weed seeds.
17. Survey of breeds of live stock, varieties of grains or types of crop rotation on farms in the locality.
18. Reports on industrial or manufacturing practices concerned with agricultural products.
19. Planting and growing of flowering bulbs.
20. Making a chart showing prices of farm products over a given period.

REFERENCE BOOKS

The reference books used for the course in General Science should be used for the corresponding topics in Agricultural Science. The following are recommended for other topics:

Elementary Entomology. Sanderson and Jackson. Ginn & Co., New York.

Manual of Plant Diseases. Heald. McGraw-Hill Book Co., New York.

Beekeeping. Phillips. Macmillan Co., Toronto.

Agricultural Bacteriology. Russell and Hastings. The Century Co., New York.

or

Bacteria. Yeasts and Moulds in the Home. Conn. Ginn & Co., New York.

Types and Breeds of Farm Animals. Plumb. Ginn & Co., New York.

Canadian Agriculture for High Schools. Macmillan Co., Toronto.

Agriculture for High Schools. Andrews. W. J. Gage & Co., Toronto.

Bulletins of the Ontario Department of Agriculture, Toronto, and the Dominion Department of Agriculture, Ottawa.

COURSES OF STUDY

For

Grades XI and XII

in

Collegiate Institutes, High and Continuation Schools

SCIENCE

The Science of Grades XI and XII is an experimental study, and emphasis should be based on pupil experiments throughout the course. Accuracy and precision in making observations, taking measurements, and reaching conclusions are the main desiderata. Encouragement should be given to the recording of experiments by means of simple line diagrams, supplemented by very brief notes. Time should not be wasted in writing copious notes from dictation or in copying material from text or manual. The pupil should not be asked to report in full more than about half a dozen outstanding experiments.

PHYSICS, GRADE XI

OBLIGATORY COURSE

Density and specific gravity. (Ten periods.)

Review the meaning of the term density and show that density may be stated in various units, such as grams per cubic centimetre, grams per litre, pounds per cubic foot or cubic inch, pounds per gallon.
The meaning of the specific gravity (s.g.) of a substance.
An experiment to determine the density and the s.g. of a regular solid, e.g., a brass cylinder, by measurement of its dimensions, and by weighing. (Use of vernier calipers recommended but not required.)
Experiments, involving the application of Archimedes' Principle, to determine the s.g. (1) of the brass cylinder used above, (2) of an irregular solid, denser than water, (3) of a liquid.
An experiment to demonstrate the principle of flotation.
The hydrometer—an experiment, using the hydrometer, to determine the s.g. of brine or other liquid.

Force and motion. (Three periods.)

Experiments to illustrate the meaning of inertia and of force and to show that force can cause a change of velocity.
Newton's First Law of Motion. The definition of force in terms of the change in velocity produced in a body.
The meaning of momentum.

Sound. (Sixteen periods.)

Experiments to show that sound has its origin in a vibrating source.
Experiments to illustrate vibratory motion using (a) the simple pendulum and (b) a spring with a weight attached.
The meaning of amplitude, period, and frequency as applied to vibratory motion.
A discussion of the action of a restoring force (elasticity) in the vibration of the spring.

The characteristics of sounds:

(1) Intensity; its dependence on the amplitude of vibration and the distance from the source (qualitative treatment only).

(2) Pitch; a demonstration of pitch using the Savart toothed wheel or the siren. The difference between tone and noise.

(3) Quality or timbre; a demonstration of differences in quality using tuning-fork, sonometer, organ pipe, etc.

An experiment to show that a material medium is necessary for the propagation of sound.

A quantitative experiment to show that the frequency of a stretched string varies inversely as the length.
A qualitative experiment to show that the frequency depends on the tension.

A discussion of wave motion, emphasizing that it is the transmission of vibration from particle to particle.
The transmission of energy by waves.
The interrelation of velocity, wave length and frequency.
An experiment to illustrate the propagation of transverse waves in any medium, e.g., in a rope or rubber tubing.

An experiment to show the way in which a stretched string vibrates—as a whole and in segments.
A discussion of the effect of the superposition of waves on the quality of the sound produced. Illustrate with two or more tuning-forks of different frequencies sounded together, or with one tuning-fork (a) bowed, (b) struck with a hard object, (c) bowed and struck so as to produce fundamental and overtone at the same time.

An experiment to illustrate the propagation of longitudinal waves in any medium, e.g., a brass coil.

A brief discussion of the reflection of sound and some of its applications.

A discussion of the measurement of the speed of sound by means of echoes or by a direct method.

Light.
—Transmission.
(Four periods.)

An experiment to show that a material medium is not required.
Rectilinear propagation (review).
An experiment to show the production of a pinhole image and the change in size of this image with variation in the distance of the screen or of the source from the pinhole.
A discussion of the reason for the formation of the image.
Simple discussion of the velocity of light.

—Reflection.
(Five periods.)

Experiments with plane mirror to derive the laws of reflection of light. Regular and diffuse reflection; discussion of direct and indirect lighting.
An experiment, using a single plane mirror, to show the location of images and the path of the rays to the eye.

Demonstrations, using a concave mirror, of (a) the focusing of parallel rays and (b) the production of a real image.

—Refraction. (Six periods.)

A demonstration of the refraction of light using (a) air and water and (b) air and glass. Explanation by means of waves.
An experiment to trace the path of light through a glass plate with parallel sides.
An experiment to show deviation produced by refraction through a prism.

—Lenses. (Six periods.)

Experiments to show the effect of a converging glass lens on parallel rays. The meaning of principal focus. The path of a ray (1) parallel to the principal axis and (2) through the centre of the lens (comparison with a ray passing obliquely through a thin glass plate). The method of locating the image.
Real and virtual images. (The pupil should be taught that there is only one general construction, and no suggestion should be made of memorizing the nature and the position of images for various positions of the object. Emphasis should be laid on the complete cone of rays which falls on the lens from any point on the object and continues through the lens to the eye.)

—Dispersion. (Three periods.)

Experiments to demonstrate the spectrum of white light, and the combination of spectrum hues to form white light.
The meaning of infra-red and ultra-violet.

—Practical applications. (Three periods.)

The camera.
The human eye; the function of its parts in the production of an image; recall iris reflex; the action of the lens in focusing the image (accommodation); comparison with the camera. (Technical terms are not required.)

Heat.

Review previous study of heat.

—Heat transfer. (Five periods.)

An experiment to show the comparative heat conductivities of different solids.
Experiments to compare the radiation and absorption by dull dark, and light polished surfaces.

The expansion of solids. An experiment to show the unequal expansion of metals. The thermostat.

—Heat measurements. (Ten periods.)

Calorimeter experiments to determine (1) the specific heat of a metal, (2) the heat of fusion of ice.

PHYSICS, GRADE XII

OBLIGATORY COURSE

Electrostatics. (Five periods.)

Experiments to show the electrification of ebonite rubbed with fur (or flannel) and of glass rubbed with silk (or chamois impregnated with tin amalgam).
The charging of a pith ball by contact. Conductors and non-conductors.
An experiment using the pith ball as an electroscope to show attraction and repulsion. An experiment to show that there are two kinds of electrification.
The use of conventional terms—positive and negative—to classify electric charges.
The construction and use of the goldleaf electroscope.

Magnetic effect of an electric current. (Fourteen periods.)

A review of elementary magnetism with a discussion of the use of lines to picture a magnetic field.
An experiment to show magnetism induced in a para-magnetic substance placed near a bar magnet.
A discussion of the difference between a temporary and a permanent magnet.

Experiments to show (1) the lines of force about a wire carrying a current and the reversal of the magnetic field with a change in the direction of the current, (2) the magnetic field due to a current in a single turn of wire, (3) the magnetic field due to a current in a helix. The principle of a galvanometer with fixed coil and moving magnet (the galvanoscope).
An experiment to show the increase in the strength of the magnetic field when an iron core is placed in a helix carrying a current.
A study of several practical applications of the electro-magnet such as the lifting magnet, electric bell, automobile generator cut-out.

An experiment to demonstrate the motor principle, that is, to show the existence of a force acting on a wire carrying a current and lying in a magnetic field, the wire being at right angles to the direction of the lines of force.

The construction and action of a galvanometer with a fixed magnet and a moving coil. (The D'Arsonval galvanometer.)
A discussion of the development of the moving coil galvan-ometer into an instrument for measuring current. (The ammeter.)

A study of the construction of a simple motor model as an application of the motor principle and as an example of the conversion of electrical energy into kinetic energy.

The chemical effects of an electric current. (Eight periods.)

Experiments to show the liberation of oxygen and hydrogen from water acidulated with sulphuric acid, and of copper from a copper sulphate solution, and to show that the amounts liberated are proportional to the strength of intensity (symbol I) of the current and to the time.
An experiment to show electroplating with copper and a discussion of electroplating with other metals.

An experiment to determine the strength or intensity of a current using the copper voltameter. Compare with the ammeter reading.
Definition of the ampere in terms of the weight of silver deposited in one second.
Definition of the coulomb as the quantity of electricity transferred when a current of one ampere flows for one second.

Explanation of a current in a wire as a flow of electrons and in a liquid as a flow of ions.
Reference to the convention that the direction of a current is that in which the positive electricity moves.

Primary and secondary cells. (Six periods.)

The meaning of potential difference.
The meaning of the electromotive force (E.M.F.) of a cell.

An experiment to show polarization in a simple zinc-copper-sulphuric acid voltaic cell. The structure of a dry cell and a discussion of the chemical means of combating polarization.

An experiment with lead plates and dilute sulphuric acid to illustrate the principle of the storage cell.
The structure, action and care of the commercial lead storage battery. (Reference to energy transformations.)

The heat effect of an electric current. (Two periods.)

A review of the transformation of electrical energy into heat energy and the subsequent radiation of energy.
A discussion of common electrical heating appliances.

Ohm's Law. (Nine periods.)

An experiment with dry cells, high resistance, and galvanometer to show that the intensity of a current is directly proportional to the potential difference (as indicated by the number of cells) causing it.

The principle of the common type of voltmeter.

An experiment to show that for any given conductor $\frac{\text{the P.D. between its ends}}{\text{current intensity}}$ is a constant. The definition of the resistance in ohms as the value of this constant when the P.D. is in volts and the current intensity in amperes.
Statement of Ohm's Law as $V = IR$. The legal definition of the ohm.
Simple problems.

The structure and use of the resistance box and the rheostat.
Experiments to determine the resistance of a conductor by
(1) method of substitution,
(2) voltmeter-ammeter method,
(3) the use of the Wheatstone bridge.

Electromagnetic induction. (Fifteen periods.)

The story of Faraday.

Experiments to show the cause of an induced current
(1) using a bar magnet, coil and galvanometer,
(2) using an electromagnet to replace the bar magnet,
(3) by the opening and closing of a primary circuit coupled with a secondary circuit.

Experiments to show the direction of the induced E.M.F. (Lenz's Law).

Experiments to show that the magnitude of an induced E.M.F. depends on (1) the strength of the changing magnetic field, (2) the number of turns of wire cut by the magnetic field, and (3) the rate at which the lines of force are cut.

An experiment with an earth inductor to show the production of alternating currents and the principle of the generator.

A discussion and demonstration of the use of a two-segment commutator to change alternating current (A.C.) into direct current (D.C.).

The transformer: the structure, action and use of a step-up and of a step-down transformer.

The telephone.

Self-inductance. An experiment to show self-induced E.M.F. when an inductive current is interrupted.

The induction coil: its structure, operation and use (details of the function of the condenser not required).

Conductivity of a gas.
(Five periods.)

An experiment to show that a charged electroscope may be discharged by a lighted match or by a gas flame held near the knob of the electroscope.

An experiment with induction coil and either a set of simple Crookes' tubes at various pressures or a single tube capable of exhaustion by a pump, to show the conductivity of air at reduced pressure.

An experiment with a Crookes' tube containing a metal obstacle, to show that cathode rays (1) travel in straight lines, (2) excite fluorescence in the walls of the tube where they strike, and (3) are deflected by a magnet.

A simple discussion of the relation of cathode rays to electrons. Explanation of the conductivity of a gas in terms of ions and electrons.

PHYSICS, GRADES XI AND XII

OPTIONAL TOPICS

The obligatory courses can probably be taught in about three-quarters of the time available. The remainder of the time should be devoted to the study of topics selected from the optional portion of the course and to review. Teachers and pupils may have, therefore, the opportunity of spending additional time on topics in which they are particularly interested.

Musical scales.	The harmonic scale. A demonstration of the major triad, major tetrad, and major diatonic scale by means of the sonometer with a string under constant tension, using successive lengths of 90 cm., 80 cm., 72 cm., 67.5 cm., 60 cm., 54 cm., 48 cm. (Similar proportions for any desired initial length may be used.) Recognition that the ratios of the vibration frequencies of successive notes in this scale comprise only three values, namely 9/8, 10/9, 16/15. Designation of these as major tone, minor tone, semitone so that the major diatonic scale is characterized by the succession, ma tone, mi tone, s.t., ma.t., mi.t., ma.t., s.t. The equally tempered scale developed from this by making no distinction between major tone and minor tone, thus—tone, tone, semitone, tone, tone, tone, semitone. Refer to piano keyboard.
Resonance.	Experiments to illustrate resonance: (1) using tuning forks or resonance bars of the same frequency (sympathetic vibrations), (2) using tuning fork and an air column whose length can be altered. The meaning of resonance with defining statement. A mechanical illustration of the principle of resonance. A brief discussion of the human voice with reference to the vocal cords and resonance.
Interference.	One or more experiments to illustrate interference, e.g., (1) silent points near a sounding tuning fork, (2) Herschel divided tube, (3) standing waves in a vibrating string (Melde's experiment), (4) the production of beats.
The ear.	A simple study of the ear to show how its parts function in the reception and transmission of vibrations. (Technical terms not required.)
Reflection.	An experiment to show the location of images and the path of the rays to the eye, using two plane mirrors at right angles.
Refraction.	An experiment to explain apparent depth in terms of refraction at a plane surface. A demonstration of total reflection; the use of a prism as a mirror. Experiments with a diverging lens as outlined for the converging lens.
Dispersion.	Complementary colours. An examination of the flame spectra of a few common elements such as sodium, calcium, and lithium and of the vacuum-tube spectra of such gases as neon, nitrogen, and hydrogen. The principle of identification of elements by their spectra. Experiments to show the effects of the transmission, reflection, and absorption of light in producing colours; colours of natural objects and of mixtures of pigments. A comparison of the effect of the combining of the colours of light with that obtained by mixing pigments.
Electrostatics.	An investigation of the effect of rubbing together various pairs of substances and a classification of the charges as positive or negative. Applications and illustrations; references to dangerous instances. An experiment to show (1) that both positive and negative charges are induced on an uncharged, insulated conductor when a charged body is brought near it, and (2) the charging of an insulated conductor by induction.

An experiment to show that a charge placed on an insulated hollow conductor goes to the outer surface.
A brief discussion of shielding with practical application, e.g., radio tubes.
An experiment to show the escape of a charge from a point. The lightning rod.

The meaning of potential difference.

Review the meaning of work, energy and power, with emphasis on gravitational potential energy.

A demonstration with a positively charged pith ball (at the end of a short silk thread tied to a glass rod) between two charged insulated plates, one positive, the other negative, to show (1) the existence of a force acting on the pith ball anywhere in the region between the plates, (2) that the pith ball, if free to move, will go from the positive to the negative plate, and (3) that work must be done on the pith ball to move it from the negative to the positive plate.

Explanation of the meaning of potential difference as a difference in potential energy and of the movement of charges, if free to move, whenever a potential difference exists. Reference to the volt as a practical unit of potential difference.

Measurement of electrical energy and electrical power.

Proof by the method given above that the energy gained when Q coulombs move in a wire under a potential difference of V volts is $V \times Q$ units and hence, that the electrical power is $V \times I$ units.

Statement that 1 volt-ampere = 1 watt; 1 watt = $\frac{1}{746}$ horse power.

The meaning of kilowatt-hour as a unit of energy.
Simple problems relating to the cost of using electrical appliances.

X-rays.

An experiment with a small X-ray tube and an induction coil to show (1) the discharge of an electroscope by X-rays, and (2) the passage of X-rays through such substances as wood and paper.
The origin of X-rays.

Thermionic emission of electrons.

An experiment with a diode tube (any radio tube may be used) to show that a current passes through the tube if (1) the filament is hot, and (2) the filament is negative with respect to the opposite electrode (Edison effect).
Simple discussion of the liberation of electrons from a hot metal.
Experiment, using A.C., to show the use of a radio tube in allowing current to flow in one direction only.
The meaning of rectifier and rectification.
Explanation of electrification in terms of electrons.

Photo-electricity.

An experiment to show that when light from an arc falls on a clean zinc plate connected to a negatively charged electroscope, the electroscope loses its charge. The meaning of photo-electricity; the structure and uses of a simple photo-electric cell.

CHEMISTRY, GRADE XI

NOTE:—Topics marked with an asterisk (*) are optional.

Change of state. (Eight periods.)

Recall freezing of water and melting of ice and snow. A study of liquefaction and solidification using naphthalene, sulphur, and a low melting point alloy such as Wood's Metal (65.5° C.), with particular reference to melting points.

Review the formation of steam from boiling water and the condensation of water vapour.
Recall the slow vaporization (evaporation) of water at room temperature and the more rapid vaporization when boiling.
A study of vaporization and condensation using carbon tetrachloride and mercury.
A demonstration of the vaporization of bromine in a closed tall cylinder.

A study of the sublimation of iodine and of benzoic acid.

An explanation of evaporation of liquids and solids in terms of molecular motion.

Definitions of the various changes of state.

Mechanical mixtures. (Eight periods.)

A discussion of the use of physical properties of substances for their identification.

The preparation and examination of suitable mechanical mixtures to illustrate their characteristics.
The application of distinguishing physical properties in the separation of the constituents of such mechanical mixtures as iron and sulphur, copper filings and charcoal, clay and water, kerosene and water, sugar and sand.
A study of natural mixtures such as (1) lake-shore sand, (2) milk, (3) tomato fruit, (4) granite.
Reference to industrial methods of separation.

Solutions. (Eight periods.)

Review water as a solvent.
A study of such types of solutions as solids in liquids, liquids in liquids, and gases in liquids.
A study of the factors affecting the rate of solution of solids and of gases in liquids.
A discussion of gaseous and solid solutions.
A study of unsaturated, saturated, supersaturated solutions.
A discussion of solubilities of various salts in water; solubility curves.

A comparison of the characteristics of solutions with those of mechanical mixtures.

Oxygen. (Eight periods.)

Recall the presence of oxygen in air and review the determination of the approximate percentage by volume.
A discussion of the importance and uses of oxygen.
Laboratory preparation by heating certain compounds of oxygen, such as mercuric oxide and potassium chlorate.
The action of manganese dioxide as a catalyst.
Commercial source of oxygen.
Occurrence in the free state and in combination.

The combustion in oxygen of charcoal (carbon), sulphur, phosphorus, magnesium, sodium and iron, and a study of the products (state, colour, solubility, and the effect of the solution upon litmus).
Recall the combustion of common foods.
Exothermic and endothermic reactions.
The properties of oxygen.

Kindling temperature; low-temperature oxidation; spontaneous combustion.

Elements and chemical compounds. (Thirteen periods.)

The burning of magnesium, iron or copper to form a new substance; increase of weight indicates the formation of a compound. The heating of the compound, mercuric oxide, to form elements; the mercury weighs less than the mercuric oxide; an element weighs less than the compound from which it is obtained.
List the substances previously met with (oxygen, nitrogen, iron, sulphur, mercuric oxide, iron rust, magnetic iron oxide, potassium chlorate, etc.) as elements or compounds.

A discussion of the meaning of element.

* A brief discussion of the structure of the atom, with specific reference to the hydrogen atom.

* Reference to the disintegration of radium.

The preparation of compounds (a) by direct union, e.g., copper sulphide, magnesium oxide, (b) by other methods, e.g., silver chloride, lead chromate, ammonium chloride.

Illustration of the law of conservation of mass.

Illustration of the law of constant composition, by the analysis of mercuric oxide and the synthesis of magnesium oxide.

A comparison of the characteristics of compounds with those of solutions and mechanical mixtures.

Reference to the elements in the compounds composing the human body, foods, clothing, etc.

Air and its constituents. (Two periods.)

Recall the composition and importance of air.
Reference to the rare gases and suspended particles.

Recall the interdependence of plants and animals.
A discussion of the processes tending (1) to increase, (2) to decrease the amount of carbon dioxide in air.
Reference to the carbon cycle.

Reasons for ventilation.

Recall the approximate percentage of nitrogen in the air.
Properties of nitrogen prepared from air.
A discussion of the importance and uses of nitrogen.

Chemistry, Grade XI

Water.
(Four periods.)

Recall widespread distribution of water.
Natural waters.
Test for presence of water.
Properties of chemically pure water (boiling point, freezing point, density at 4° C.).
Potable water as compared with chemically pure water.
Recall water as a solvent and the importance of this in chemistry.
Water of hydration.
Deliquescence and efflorescence.

Hydrogen.
(Seven periods.)

Preparation of hydrogen by (1) electrolysis of water, (2) the reaction of metals with water, (3) the reaction of zinc and diluted sulphuric acid.
Properties and uses of hydrogen.
Demonstration of the use of hydrogen as a reducing agent in the determination of the percentage composition by weight of water.

Acids and bases.
(Three periods.)

Recall the effect of acids on litmus.
Discover further properties of acids (dilute) using (1) other indicators, (2) action on carbonates, (3) action on suitable metals (magnesium), (4) taste as shown by soda-water, vinegar, sour milk, etc.

Discover the effect of bases on the same indicators as used for acids.

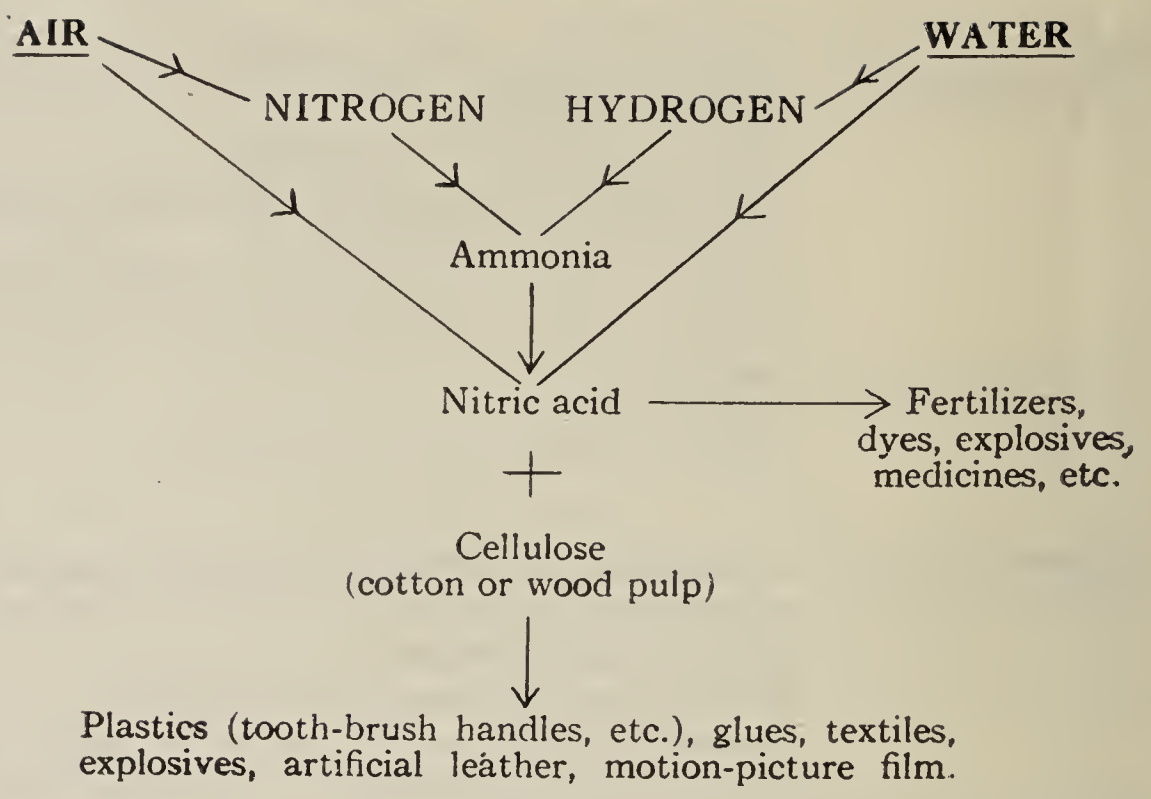
Recall the action upon litmus of the solutions of the oxides of the substances already burned in oxygen and classify as acid or basic oxides.

Test a number of substances found in the household and classify them as having acidic or basic or neutral properties.

The reaction of an acid with a base to form a salt and water (neutralization).

Chemistry at work.
(Four periods.)

This brief glance at chemistry in industry is inserted at this place to show the use in modern chemical processes of the common substances already studied and in this way to reveal to the student the relation of this science to everyday life. The reactions producing ammonia and nitric acid should be discussed without the use of formulae; the various other substances should be referred to as interesting and important derivatives of nitric acid, without involving any technical details of manufacture. The chart is intended to show the orderly production of more complex substances from simple materials, and is not to be memorized by the pupil. Where possible the discussion should be supplemented by examination of the materials.



Carbon and its compounds. (Seven periods.)

Sources and properties of the different forms of carbon. Allotropism.
Uses of carbon in its various forms for lubrication, fuel, reduction, adsorption, etc.

Recall the properties and uses of carbon dioxide.
The preparation of carbon dioxide by the action of acids on carbonates and a detailed study of its properties.
The action of baking soda in a baking powder.
The effect of pressure on the solubility of carbon dioxide in water (Henry's Law).
The action of heat on carbonates.

The sources of carbon monoxide; dangerous and useful properties.

The preparation, properties and uses of acetylene.

Recall carbon in fats, carbohydrates, and proteins.

Fuels. (Five periods.)

General survey of solid, liquid, and gaseous fuels.

Heat of combustion—a transformation of chemical potential energy to heat energy.
A comparison of the calorific value of various fuels.

Flame—a product of burning gas; complete and incomplete combustion.

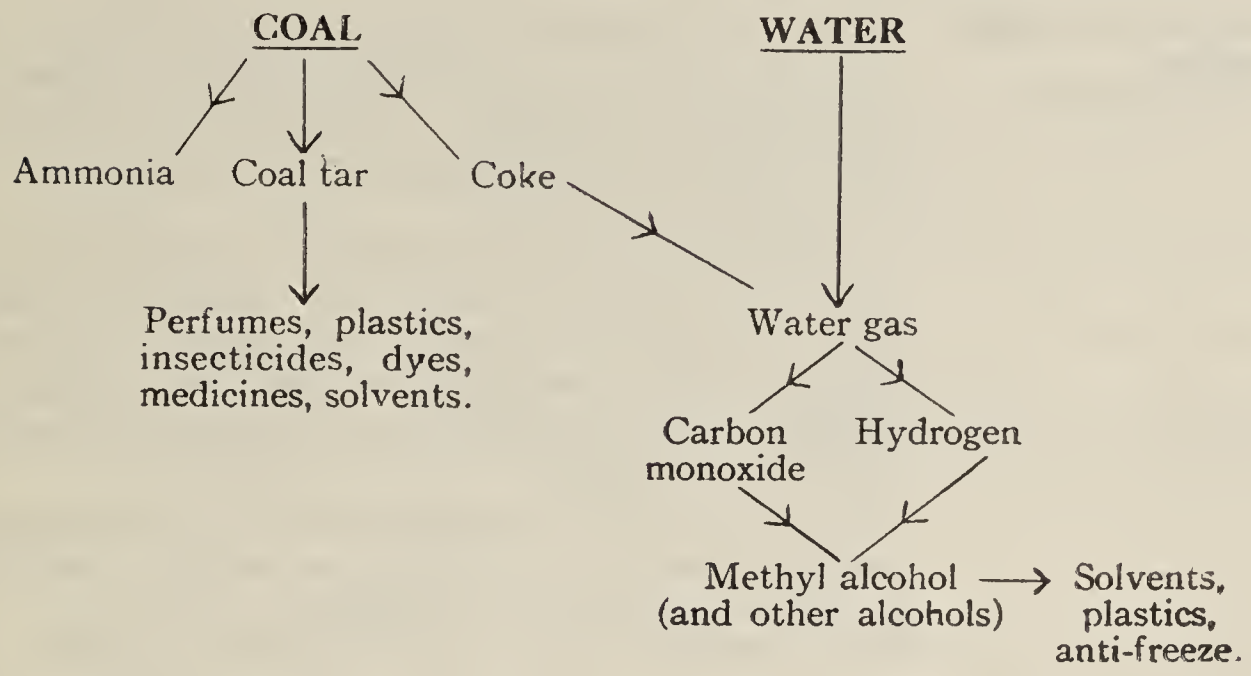
The destructive distillation of coal; reference to the important products obtained.

A demonstration of fractional distillation; reference to its application in the refining of petroleum.

Chemistry at work. (Four periods.)

This second glance at chemistry in industry is inserted for the same purpose as the preceding one.
The various substances should be referred to as interesting and important commercial derivatives, without involving any technical details of manufacture.

The chart is not to be memorized, and where possible the discussion should be supplemented by examination of the materials.



CHEMISTRY, GRADE XII

Review.
(Ten periods.)

An experimental review of the course of Grade XI. It is suggested that the review be conducted as demonstrations by pupils.

The law of reacting weights.
(Six periods.)

Repeat the determination of the percentage composition of mercuric oxide and magnesium oxide. Recall the percentage composition of water. Calculate the weights of mercury, magnesium and hydrogen that combine with a fixed weight of oxygen (16 grams).
A consideration of a number of quantitative results from reactions involving only pure substances such as mercuric oxide, mercuric chloride, mercurous chloride, hydrogen chloride, zinc oxide, zinc chloride, chosen to show the weights of the elements as related through one another to 16 g. of oxygen.
The use of these weights to show that elements (and compounds) react in proportion to certain characteristic weights or simple multiples of them.
These weights are called reacting weights.

Symbols, formulae and equations.
(Ten periods.)

The atomic weight—a selected reacting weight.
Symbols as abbreviations for atomic weights.
Determination of the formulae for the compounds which were discussed under the law of reacting weights.
Information regarding a pure substance given by its formula. (elemental composition, reacting weight).
Simple problems to find (1) the reacting weight of an element from the composition of its oxide, (2) the formula from the percentage composition, (3) the percentage composition of a compound from its formula.
The use of simple equations to represent the chemical reactions involved in experiments performed throughout the year. (Stress the fact that an equation is a record of a reaction which has actually occurred.)

Simple problems to show the use of the equation to calculate the relative weights of the substances taking part in a reaction.

NOTE:—The molecular formulae of the gases should be used in the equations and **may** be given at this stage without attempting to explain how they were determined.

Molecular formulae of gases.
(Eight periods.)

Review the compressibility of gases.
Recall the barometer and the process of measuring atmospheric pressure. Discussion of the measurement of the pressure of a gas in millimetres (or inches) of mercury, and in atmospheres. An experimental demonstration of the pressure-volume relationship in gases (Boyle's Law).

An experimental demonstration of the temperature-volume relationship in gases (Charles's Law).
Comparison of the Centigrade and Absolute scales of temperature.

Problems involving the gas laws; emphasis to be placed on principles (thermodynamic formulae not required).

A demonstration of the reacting volumes of gases, such as hydrogen and oxygen, by using the eudiometer.
A discussion of the reacting volumes of gases to develop Gay-Lussac's Law.
A statement of Avogadro's Hypothesis as an explanation of the reacting weight-volume relationships.
Information given by the molecular formulae of gases.
Simple problems on reactions involving gaseous substances.

Valency and nomenclature. (Five periods.)

Experimental determination of the valency of magnesium.
The application of valency in writing formulae.
The application of the rules of nomenclature in the naming of such binary compounds, acids, bases and salts as are met in the course.

Sulphur and its compounds. (Eight periods.)

Sources of sulphur.
The preparation of the allotropes (rhombic, monoclinic, plastic).
Properties and uses of sulphur.

Demonstration of the preparation of hydrogen sulphide and its use in the preparation of metallic sulphides. (Note the tendency of some of these sulphides, such as arsenic, antimony and zinc, to pass through filter paper.)

The laboratory preparation of sulphur dioxide
The properties of its solution and its uses, e.g., bleaching and the production of sulphites (chemical wood pulp).

The principles of the commercial production of sulphuric acid (processes not required).
The properties and uses of sulphuric acid.

References to such sulphates as those of magnesium, copper, calcium.
Test for soluble sulphates.

Common salt. (Four periods.)

A brief discussion of the commercial recovery and industrial importance of salt.
A study of its properties.
A study of the reaction of sulphuric acid and of phosphoric acid with salt.

The laboratory preparation and properties of hydrogen chloride and of hydrochloric acid.

Sodium and potassium. (Three periods.)

The action of air on sodium and on potassium.
A review of the reaction of these metals with water.
A discussion of the properties of metals as illustrated by sodium and potassium.
A comparison of the properties of sodium hydroxide and potassium hydroxide.
The flame test for the presence of sodium and of potassium.

Chlorine, bromine and iodine. (Nine periods.)

A discussion of the production of chlorine by the electrolysis of salt.
Experiments to prepare chlorine in test-tubes by the oxidation of hydrogen chloride (as hydrochloric acid).
A demonstration of the preparation and collection of chlorine and a detailed study of its properties.
An experimental study of the properties of an aqueous solution of chlorine.

A demonstration of the preparation and collection of bromine and an experimental study of its properties.
A demonstration of the relative activity of chlorine and of bromine vapour by comparison of the reactions with antimony, moist blue litmus paper, and solutions of sodium chloride, sodium bromide and sodium iodide.
Commercial sources and uses of bromine.

A demonstration of the preparation and collection of iodine.
An experimental study of the properties and uses of iodine.

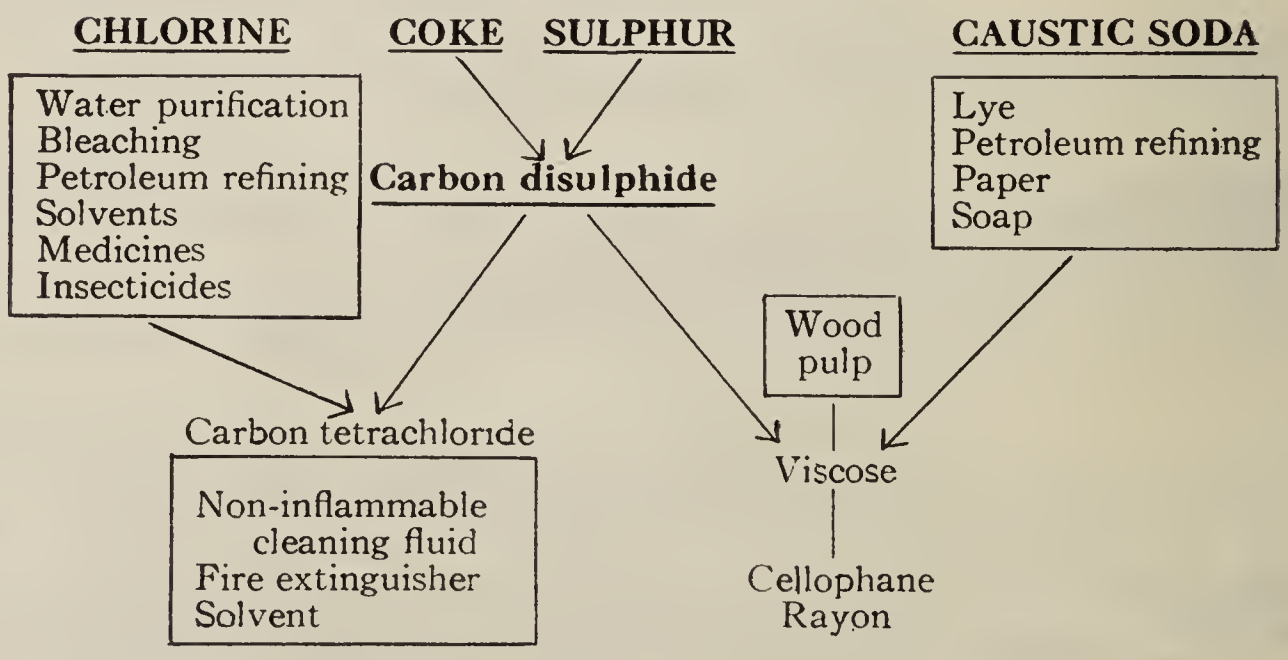
A comparison of the properties of chlorine, bromine, and iodine.

Qualitative tests to identify a chloride, a bromide, and an iodide.

Chemistry at work. (Six periods.)

In this third brief glance at chemistry in industry, the reactions producing carbon disulphide and carbon tetrachloride should be studied quantitatively. The manufacture of viscose should be examined, without involving technical details of manufacture, as a typical example of the creative combination of simple substances.

The chart is not to be memorized, and where possible the discussion should be supplemented by examination of the materials. The blocks list a few commercial uses to which brief reference should be made.



Compounds of nitrogen. (Seven periods.)

Recall the properties of nitrogen.

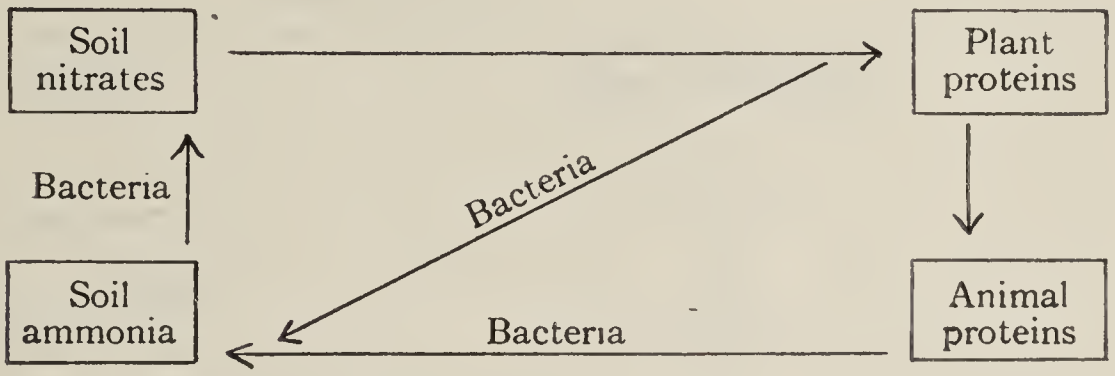
Laboratory preparation of nitric acid; its acid properties when diluted; its oxidizing action when concentrated; its uses; its toxic effect.

The properties and uses of such nitrates as those of sodium, potassium, ammonium and calcium.
The brown-ring test for nitrates.

Laboratory preparation of ammonia; its properties and uses.
Properties of a solution of ammonia.

Brief discussion of the formation and properties of such ammonium salts as ammonium chloride and ammonium sulphate.

Nitrogen and soil fertility—simple explanation of the nitrogen cycle.



*Rare gases.
(Two periods.)

* Recall the presence of rare gases in the air.
* Discuss their chemical inactivity and commercial uses.
* Commercial source of helium. Briefly discuss the history of the discovery of these gases, emphasizing the importance of precise and painstaking research.

Calcium and its compounds.
(Four periods.)

Recall the reaction of calcium with water.

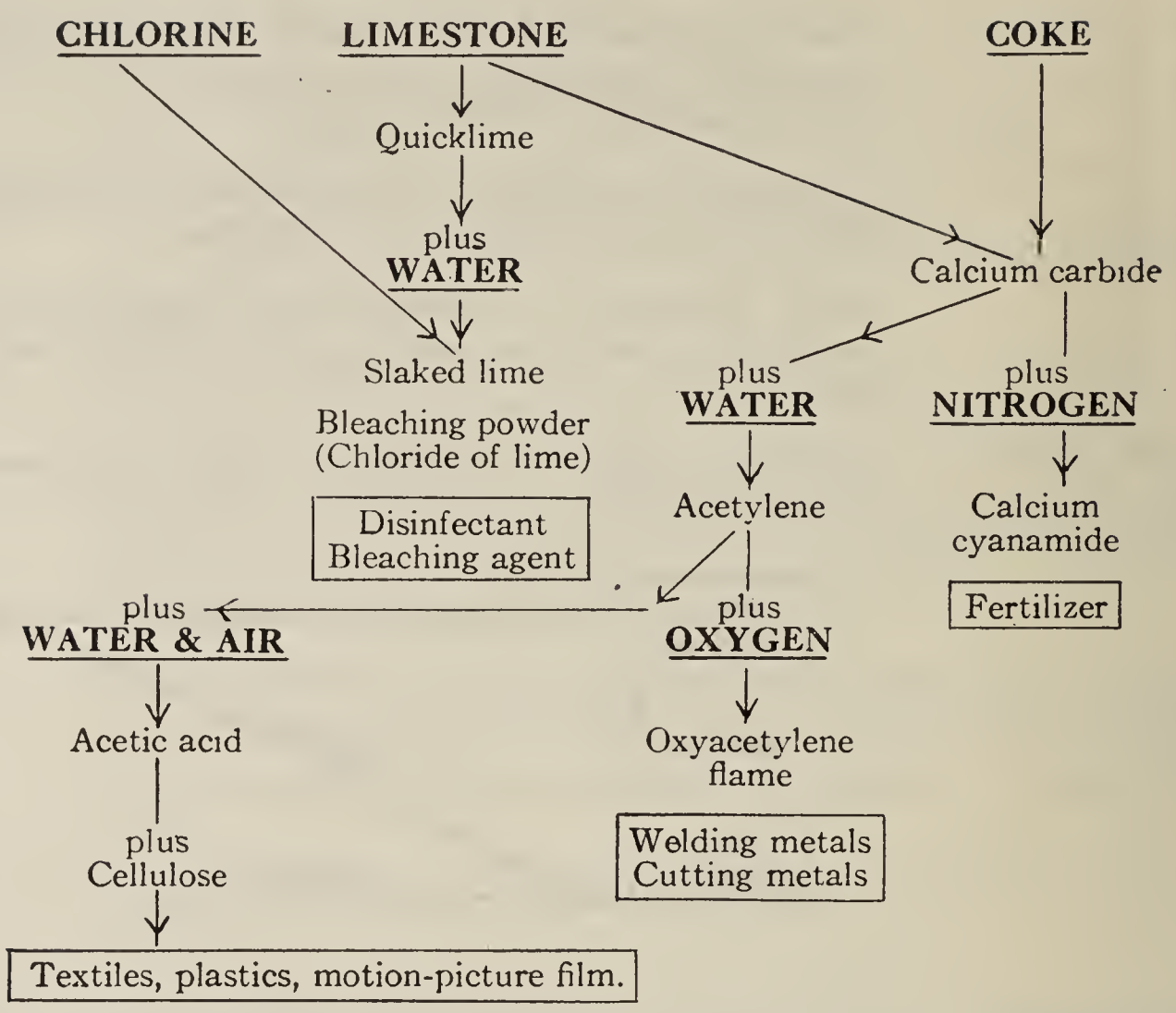
Occurrence of calcium carbonate (limestone and marble). Heating of calcium carbonate. The commercial preparation of quicklime. The slaking of quicklime.

Commercial uses of limestone, quicklime, slaked lime, gypsum, bleaching powder, calcium chloride.

Chemistry at work.
(Six periods.)

In this fourth glance at chemistry in industry, all the reactions should be studied quantitatively except those involving the preparation and use of acetic acid. The discussion should afford an opportunity to refer to the economic interdependence of industrial chemical processes. As before, the chart is not to be memorized, and the discussion should be supplemented by reference to Canadian manufacturing plants, and by examination of the materials. The blocks list a few commercial uses to which brief reference should be made.

*Optional


CHLORINE
LIMESTONE
COKE
Quicklime
plus
WATER
Calcium carbide
Slaked lime
Bleaching powder
(Chloride of lime)
Disinfectant
Bleaching agent
plus
WATER
plus
NITROGEN
Acetylene
Calcium
cyanamide
Fertilizer
plus
WATER & AIR
plus
OXYGEN
Acetic acid
Oxyacetylene
flame
plus
Cellulose
Welding metals
Cutting metals
Textiles, plastics, motion-picture film.

COURSES OF STUDY
For
Grades XI and XII
in
Collegiate Institutes, High and Continuation Schools

Schools in which Agriculture of the lower school course has been taught for at least two years, and in which it is intended to introduce Agricultural Science in the middle school at the commencement of the school year and thus qualify for the annual grants, shall make written application to the Deputy Minister before September 15th, for permission to undertake the work. This notice shall be signed by the Chairman of the Board as well as by the Principal.

The objectives outlined for Grades IX and X apply also to Agricultural Science of Grades XI and XII. These courses include the essential topics of the courses in physics and chemistry and a number of agricultural topics, the study of which will enlarge and extend the work begun in Grades IX and X. The obligatory agricultural topics as outlined should be taught in the regular school programme. As far as possible, individual interest and initiative should be encouraged and the instruction in laboratory and class room correlated with practical activities outside of school. Display of special equipment, illustrative charts and other material related to Agriculture should be arranged in the laboratory. School experimental plots, home projects and agricultural reading are optional topics which should be taken under the conditions suggested in the syllabus.

The science topics of Grades XI and XII should be treated experimentally and emphasis placed on pupil experiments throughout the course. Accuracy and precision in making observations, taking measurements and reaching conclusions are the main desiderata. Encouragement should be given to the recording of experiments by means of simple line diagrams, supplemented by very brief notes. Time should not be wasted in writing copious notes from dictation or in copying material from text or manual. It should not be demanded of the student to report in full form more than about, say, half a dozen outstanding experiments. The pupils' note-books should, however, contain a systematic record of the work covered.

AGRICULTURAL SCIENCE, PART I, GRADE XI

OUTLINE OF THE COURSE (Grade XI)

NOTE:—Topics marked with an asterisk (*) are optional.

Botany. (Ten periods.)	Parasitic fungi; the examination and recognition in different stages and methods of control of stem rust of wheat, loose smut of oats, covered smut of barley, late blight of potatoes, brown rot of stone fruits, any mildew (cherry, lilac, grape), anthracnose of bean; also the effect of these diseases on the grading and market value of farm products.
Entomology. (Ten periods.)	Life history and nature of injury and methods of control of white grub or wire worm, plum curculio or potato beetle, oyster shell scale or aphides, cabbage butterfly or tomato worm, tent caterpillar or European corn borer, warble fly or bot fly.

The effect of insect injuries on the market value of farm products.
Reference to the spray calendar and spray service.

Density and specific gravity. (Ten periods.)

Review the meaning of the term density, and show that density may be stated in various units, such as grams per cubic centimetre, grams per litre, pounds per cubic foot or cubic inch, pounds per gallon.
The meaning of the specific gravity (s.g.) of a substance.
An experiment to determine the density and the s.g. of a regular solid, e.g., a brass cylinder, by measurement of its dimensions, and by weighing. (Use of vernier calipers recommended, but not required.)
Experiments involving the application of Archimedes' Principle, to determine the s.g. (1) of the brass cylinder used above; (2) of an irregular solid, denser than water; (3) of a liquid.
An experiment to demonstrate the principle of flotation.
The hydrometer; an experiment, using the hydrometer, to determine the s.g. of brine or other liquid; or using the lactometer to determine the specific gravity of milk.

Force and motion. (Three periods.)

Experiments to illustrate the meaning of inertia and of force, and to show that force can cause a change of velocity.
Newton's First Law of Motion. The definition of force in terms of the change in velocity produced in a body. The meaning of momentum.

Mechanics. (Five periods.)

Review of levers and pulleys. Applications in farm machinery and appliances.

Light.
—Transmission. (Four periods.)

An experiment to show that a material medium is not required.
Rectilinear propagation (review).
An experiment to show the production of a pinhole image and the change in size of this image with variation in the distance of the screen or of the source of light from the pinhole. A discussion of the reason for the formation of the image.
Simple discussion of the velocity of light.

—Reflection. (Five periods.)

Experiments with plane mirror to derive the laws of reflection of light. Regular and diffuse reflection; discussion of direct and indirect lighting.
An experiment, using a single plane mirror, to show the location of images and the path of the rays to the eye.
Demonstrations, using a concave mirror, of (a) the focusing of parallel rays and (b) the production of a real image.

—Refraction (Six periods.)

A demonstration of the refraction of light using (a) air and water and (b) air and glass. Explanation by means of waves.
An experiment to trace the path of light through a glass plate with parallel sides.
An experiment to show deviation through a prism.

—Lenses.
(Four periods.)

Experiments to show the effect of a converging glass lens on parallel rays. The meaning of principal focus. The path of a ray (1) parallel to the principal axis and (2) through the centre of the lens (comparison with a ray passing obliquely through a thin glass plate). The method of locating the image and drawing ray paths to the eye as shown in converging lenses. Explanation of how the eye sees the image in a simple microscope or magnifying lens.

—Dispersion.
(Three periods.)

Experiments to demonstrate the spectrum of white light, and the combination of spectrum hues to form white light. The meaning of infra-red and ultra-violet.

Heat.
—Heat transfer.
(Five periods.)

Review previous study of heat.

An experiment to show the comparative heat conductivities of different solids.
Experiments to compare the radiation and absorption by dull, dark, and light polished surfaces.

The expansion of solids. An experiment to show the unequal expansion of metals. The thermostat as illustrated in the incubator.

—Heat measurements.
(Ten periods.)

Calorimeter experiments to determine (1) the specific heat of a metal, (2) the heat of fusion of ice.

Landscaping.
(Five periods.)

Recall making and care of a lawn; a suitable lawn seed mixture.
Formal and natural landscaping plans. The location of walks or paths, the use of curves and open spaces, relation of plantings of different heights.
Planting material; annual, biennial and perennial flowering plants, and shrubs suitable for different locations and for the best seasonal display. Planting plans for home and school gardens.

* Co-operation with local Horticultural Society in pupils' projects.

*Light.
—Practical applications.
(Three periods.)

The camera.
The human eye; the function of its parts in the production of an image; recall iris reflex; the action of the lens in focusing the image (accommodation); comparison with the camera. (Technical terms are not required.)

*Sound.
(Ten periods.)

Experiments to show that sound has its origin in a vibrating source.
The meaning of amplitude, period, and frequency as applied to vibratory motion.
The characteristics of sounds:

(1) Intensity; its dependence on the amplitude of vibration and the distance from the source (qualitative treatment only).
(2) Pitch; a demonstration of pitch using the Savart toothed wheel or the siren. The difference between tone and noise.

(3) Quality or timbre; a demonstration of differences in quality using tuning-fork, sonometer, organ pipe, etc.

An experiment to show that a material medium is necessary for the propagation of sound.

A quantitative experiment to show that the frequency of a stretched string varies inversely as the length.

A qualitative experiment to show that the frequency depends on the tension.

The interrelation of velocity, wave length and frequency.

A brief discussion of the reflection of sound and some of its applications.

A discussion of the measurements of the speed of sound by means of echoes or by direct methods.

*Home projects.

Under the supervision of the teacher, suitable home projects, preferably of an economic value, should be undertaken by selected pupils of the middle school. In lower school, the type of home project which can be continued into Grades XI and XII should be encouraged. In many cases, such projects may be associated with the local Junior Club programme.

The following suggested projects are suitable for this type of treatment:

(1) Home grounds beautification.
(2) The improvement of the poultry flock by introduction of egg-laying strains and keeping of records.
(3) Improvement of the dairy herd by (1) starting with a pure-bred calf or (2) by keeping records and selection.
(4) The building up of an apiary.
(5) Permanent pasture improvement.
(6) Improvement of crops by plant and seed selection.
(7) Growing of plots of recommended varieties of potatoes, pasture grasses, or grains from certified seed.
(8) Soil improvement by crop rotation and fertilizer treatment over a period of years.
(9) In fruit-growing areas, the introduction of approved varieties by grafting and planting.

*Gardening.

Elementary gardening practice in planting and care of vegetables and flowers has been covered in Grades IX and X.

Gardening activities **if continued in middle school** should be taken with Grade XI pupils, and must be of a definite practical nature such as a school-ground improvement programme, planting and care of beds of perennial flowers or shrubs, the making of a lawn or the conducting of experimental plots with varieties of grasses, grains, potatoes or other crops with or without fertilizers on plots 1/100 of an acre or 436 sq. feet in area. Garden plots for the middle school should contain at least four such areas.

*Agricultural reading.

In the average middle school class and particularly in the smaller schools, there are a number of boys who come from

farm homes and who, after leaving school, are likely to engage in farming. These pupils may have developed an interest in certain agricultural topics and would benefit from more information on the subject than has been offered in the classroom study. The teacher should try to assist such pupils by providing a suitable list of references for reading and study from books, bulletins and magazines which are in the library. In the case of pupils who are not taking all subjects of the middle school course, at least a part of the free periods should be given to such reading and study.

AGRICULTURAL SCIENCE, PART I, GRADE XII

OUTLINE OF THE COURSE (Grade XII)

NOTE:—Topics marked with an asterisk (*) are optional

Electrostatics. (Five periods.)

Experiments to show the electrification of ebonite rubbed with fur (or flannel) and of glass rubbed with silk (or chamois impregnated with tin amalgam).
The charging of a pith ball by contact. Conductors and non-conductors.
An experiment using the pith ball as an electroscope to show attraction and repulsion. An experiment to show that there are two kinds of electrification.
The use of conventional terms; positive and negative—to classify electric charges.
The construction and use of the goldleaf electroscope.
An experiment to show the escape of a charge from a point.
The lightning rod.

Magnetic effect of an electric current. (Fourteen periods.)

A review of elementary magnetism with a discussion of the use of lines to picture a magnetic field.
An experiment to show magnetism induced in a para-magnetic substance placed near a bar magnet.
A discussion of the difference between a temporary and a permanent magnet.

Experiments to show (1) the lines of force about a wire carrying a current and the reversal of the magnetic field with a change in the direction of the current, (2) the magnetic field due to a current in a single turn of wire, (3) the magnetic field due to a current in a helix. The principle of a galvanometer with fixed coil and moving magnet (the galvanoscope).
An experiment to show the increase in the strength of the magnetic field when an iron core is placed in a helix carrying a current.
A study of several practical applications of the electro-magnet such as lifting magnet, electric bell, automobile generator cut-out.

An experiment to demonstrate the motor principle, that is, to show the existence of a force acting on a wire carrying a current and lying in a magnetic field, the wire being at right angles to the direction of the lines of force.

The construction and action of a galvanometer with a fixed magnet and a moving coil. (The D'Arsonval galvanometer.)
A discussion of the development of the moving coil galvan-ometer into an instrument for measuring current (the ammeter).

A study of the construction of a simple motor model as an application of the motor principle and as an example of the conversion of electrical energy into kinetic energy.

The chemical effects of an electric current.
(Eight periods.)

Experiments to show the liberation of oxygen and hydrogen from water acidulated with sulphuric acid, and of copper from a copper sulphate solution, and to show that the amounts liberated are proportional to the strength or intensity (symbol I) of the current and to the time.
An experiment to show electroplating with copper and a discussion of electroplating with other metals.
An experiment to determine the strength or intensity of a current using the copper voltameter. Compare with the ammeter reading.
Definition of the ampere in terms of the weight of silver deposited in one second.
Definition of the coulomb as the quantity of electricity transferred when a current of one ampere flows for one second.
Explanation of a current in a wire as a flow of electrons and in a liquid as a flow of ions.
Reference to the convention that the direction of a current is that in which the positive electricity moves.

Primary and secondary cells.
(Six periods.)

The meaning of potential difference.
The meaning of the electromotive force (E.M.F.) of a cell.
An experiment to show polarization in a simple zinc-copper-sulphuric acid voltaic cell. The structure of a dry cell and a discussion of the chemical means of combating polarization.
An experiment with lead plates and dilute sulphuric acid to illustrate the principle of the storage cell.
The structure, action and care of the commercial lead storage battery. (Reference to energy transformations.)

The heat effect of an electric current.
(Two periods.)

A review of the transformation of electrical energy into heat energy and the subsequent radiation of energy.
A discussion of common electrical heating appliances.

Ohm's Law.
(Two periods.)

An experiment with dry cells, high resistance, and galvanometer to show that the intensity of a current is directly proportional to the potential difference (as indicated by the number of cells) causing it. Statement and explanation of Ohm's Law. $V = IR$.
The principle of the common type of voltmeter.

Electromagnetic induction.
(Fifteen periods.)

The story of Faraday.

Experiments to show the cause of an induced current
(1) using a bar magnet, coil and galvanometer,
(2) using an electromagnet to replace the bar magnet,
(3) by the opening and closing of a primary circuit coupled with a secondary circuit.

Experiments to show the direction of the induced E.M.F. (Lenz's Law).
Experiments to show that the magnitude of an induced E.M.F. depends on (1) the strength of the changing magnetic field, (2) the number of turns of wire cut by the magnetic field, and (3) the rate at which the lines of force are cut.
An experiment with an earth inductor to show the production of alternating currents and the principle of the generator.

A discussion and demonstration of the use of a two-segment commutator to change alternating current (A.C.) into direct current (D.C.).

The transformer: the structure, action and use of a step-up and of a step-down transformer.

The telephone.

Self-inductance. An experiment to show self-induced E.M.F. when an inductive current is interrupted.

The induction coil: its structure, operation and use (details of the function of the condenser not required).

Field crops.
(Four periods.)

* History of crop improvement with special reference to O.A.C. 21, barley, marquis wheat, O.A.C. 72, oats, etc. (Special emphasis should be given to crops grown in the local area.)
* Kinds of crops, common types of farming, with special reference to the distribution and economic value of crops in the local area.
* Crop distribution in Ontario.

(Eight periods.)

A discussion of the meaning of crop rotation with examples from farms in the local area; importance and value; surveys of crop rotations.

Identification of weed seeds in grains such as wheat, oats and barley, in timothy and in clover or alfalfa (at least ten weed seeds to be identified). The importance of pure seed in relation to weed control.
Examination of a sample of grain to show the value of cleaning seed.
Germination tests.

Use of bulletins and literature in the discussion of new varieties (sources of information and their use).

Live Stock.
(Ten periods.)

Review of principle types and breeds of cattle, draught horses and swine with emphasis on the distinguishing characteristics and importance of each.
Principles of judging and improvement of breeds.
Chief market cuts of meat; grades of meat.

* Visits to local farms to study methods of stabling and care of cattle.

OR

Fruit growing.
(Ten periods.)

Orchard management: planning and planting the orchard; pruning, grafting, spraying, cultivating, fertilizing; use of cover crops.
Orchard fruits: late and early varieties, time of marketing; length of life of trees and age of bearing.
Harvesting, packing and marketing; grading and types of packing for two different kinds of fruits of the locality; cold storage and natural storage.
Planting, care and marketing of strawberries and raspberries; recommended varieties.

* Visits to fruit farms and packing houses to study methods employed there.

AGRICULTURAL SCIENCE, PART II, GRADE XI

OUTLINE OF THE COURSE (Grade XI)

NOTE:—Topics marked with an asterisk (*) are optional.

Change of state.
(Six periods.)

Recall freezing of water and melting of ice and snow. A study of liquefaction and solidification using naphthalene, or sulphur and a low-melting-point alloy such as Wood's Metal (65.5° C.), with particular reference to melting points.

Review the formation of steam from boiling water and the condensation of water vapour.
Recall the slow vaporization (evaporation) of water at room temperature and the more rapid vaporization when boiling.
A study of vaporization and condensation using carbon tetrachloride and mercury.

A study of the sublimation of iodine or of benzoic acid.
An explanation of evaporation of liquids and solids in terms of molecular motion.

Definitions of the various changes of state.

Mechanical mixtures.
(Eight periods.)

A discussion of the use of physical properties of substances for their identification.

The preparation and examination of suitable mechanical mixtures to illustrate their characteristics.
The application of distinguishing physical properties in the separation of the constituents of such mechanical mixtures as iron and sulphur, copper filings and charcoal, clay and water, kerosene and water, sugar and sand. Recall separation of samples of soils.
A study of natural mixtures such as (1) lake-shore sand, (2) milk, (3) tomato juice, (4) granite.
Reference to industrial methods of separation, including the cream separator.

Solutions.
(Eight periods.)

Review water as a solvent.
A study of such types of solutions as solids in liquids, liquids in liquids, and gases in liquids.
A study of the factors affecting the rate of solution of solids and of gases in liquids.
A discussion of gaseous and solid solutions.
A study of unsaturated, saturated, supersaturated solutions.
A discussion of solubilities of various salts in water; solubility curves.

A comparison of the characteristics of solutions with those of mechanical mixtures.

Recall soil water as a solution.

Oxygen.
(Eight periods.)

Recall the presence of oxygen in air and review the determination of the approximate percentage by volume.
Laboratory preparation by heating certain compounds of oxygen, such as mercuric oxide and potassium chlorate.
The action of manganese dioxide as a catalyst.

Occurrence of oxygen in the free state and in combination. The combustion in oxygen of charcoal (carbon), sulphur, phosphorus, magnesium, sodium and iron, and a study of the products (state, colour, solubility, and the effect of the solution upon litmus).
Recall the combustion of common foods.
Exothermic and endothermic reactions.
The properties of oxygen. Importance and uses of oxygen.

Kindling temperature; low-temperature oxidation; spontaneous combustion.

Elements and chemical compounds. (Thirteen periods.)

The burning of magnesium, iron or copper to form a new substance; increase of weight indicates the formation of a compound. The heating of the compound, mercuric oxide, to form elements; the mercury weighs less than the mercuric oxide; an element weighs less than the compound from which it is obtained.
List the substances previously met with (oxygen, nitrogen, iron, sulphur, mercuric oxide, iron rust, magnetic iron oxide, potassium chlorate, etc.) as elements or compounds.

A discussion of the meaning of element.

* A brief discussion of the structure of the atom with specific reference to the hydrogen atom.
* Reference to the disintegration of radium.

The preparation of compounds (a) by direct union, e.g., copper sulphide, magnesium oxide, (b) by other methods, e.g., silver chloride, lead chromate, ammonium chloride.

Illustration of the law of conservation of mass.

Illustration of the law of constant composition by the analysis of mercuric oxide and the synthesis of magnesium oxide.

A comparison of the characteristics of compounds with those of solutions and mechanical mixtures.

Reference to the elements in the compounds composing the human body, foods, clothing. etc.

Reference to elements most important for plant growth obtained from air, water and soil.

Air and its constituents. (Two periods.)

Recall the composition and importance of air.
Reference to the rare gases and suspended particles.
Recall the interdependence of plants and animals.
A discussion of the processes tending (1) to increase, (2) to decrease the amount of carbon dioxide in air.
Reference to the carbon cycle.

Reasons for ventilation. Applications in farm buildings.

Recall the approximate percentage of nitrogen in the air.
Properties of nitrogen prepared from air.
A discussion of the importance and uses of nitrogen.

Water.
(Four periods.)

Recall widespread distribution of water.
Natural waters.
Test for presence of water.
Properties of chemically pure water (boiling point, freezing point, density at 4° C.).
Potable water as compared with chemically pure water.
Recall water as a solvent and the importance of this in chemistry.
Solvent action of water in relation to weathering of soils, availability of nutrients and losses by leaching.
Water of hydration.
Deliquescence and efflorescence.

Hydrogen.
(Five periods.)

Preparation of hydrogen by (1) electrolysis of water, (2) the reaction of metals with water, (3) the reaction of zinc and diluted sulphuric acid.
Properties and uses of hydrogen. Reference to the use of hydrogen as a reducing agent.

Acids and bases.
(Three periods.)

Recall the effect of acids on litmus.
Discover further properties of acids (dilute), using (1) other indicators, (2) action on carbonates, (3) action on suitable metals (magnesium), (4) taste, as shown by soda water, vinegar, sour milk, etc.

Discover the effect of bases on the same indicators as used for acids.

Recall the action upon litmus of the solutions of the oxides of the substances already burned in oxygen and classify as acid or basic oxides.

Test a number of substances found in the household and on the farm (spray materials and fertilizers) and classify them as having acidic or basic or neutral properties (home activity).

Recall acidity and alkalinity of soils.

Carbon and its compounds.
(Eight periods.)

Sources and properties of the different forms of carbon.
Allotropism.
Uses of carbon in its various forms for lubrication, fuel, reduction, adsorption, etc
Recall the properties and uses of carbon dioxide.
The preparation of carbon dioxide by the action of acids on carbonates and a detailed study of its properties.
The action of baking soda in a baking powder.
The effect of pressure on the solubility of carbon dioxide in water (Henry's Law)
The action of heat on carbonates.

The sources of carbon monoxide; dangerous and useful properties.

Recall carbon in fats, carbohydrates and proteins

Recall source of carbon in plants.

Fuels.
(Three periods.)

General survey of solid, liquid and gaseous fuels.

Heat of combustion; a transformation of chemical potential energy to heat energy.

Flame; a product of burning gas, complete and incomplete combustion.

Poultry.
(Ten periods.)

The structure of the egg, candling and grading of eggs, methods of preserving eggs; food value of eggs; culling poultry for egg production. The meaning of the term "dressed" fowl; methods of finishing, killing and plucking; marketing eggs and dressed poultry.

The essentials of poultry-house construction to provide proper lighting, ventilation, dryness and freedom from draughts; feeding for egg production.

* Examination of eggs broken open every one or two days during incubation to observe the stages in the development of the embryo.

Dairying.
(Eight periods.)

The principle of the Babcock test; the use of this test in determining the percentage of fat in cream and skim milk.

Butter-making; operation and care of the cream separator; washing, sterilization and care of dairy utensils; care of cream on the farm; making butter with a laboratory churn.

Experiment to determine the percentage of water in a sample of butter; sale of butter by grade.

Distribution and importance of the dairy industry in Ontario; commercial milk products and their importance.

AGRICULTURAL SCIENCE, PART II, GRADE XII

OUTLINE OF THE COURSE (Grade XII)

Review.
(Eight periods.)

A review of the course of Grade XI.

The law of reacting weights.
(Four periods.)

The recall of the percentage composition of mercuric oxide, magnesium oxide and water; the calculation of the weights of mercury, magnesium and hydrogen that combine with a fixed weight of oxygen (16 grams).
The consideration of a number of quantitative results from reactions involving only pure substances such as mercuric oxide, mercuric chloride, mercurous chloride, hydrogen chloride, zinc oxide, zinc chloride, chosen to show the weights of the elements as related through one another to 16 grams of oxygen.
The use of these weights to show that elements (and compounds) react in proportion to certain characteristic weights or simple multiples of them.
These weights are called reacting weights.

Symbols, formulae and equations.
(Ten periods.)

The atomic weight, a selected reacting weight.
Symbols as abbreviations for atomic weights.
Determination of the formulae for the compounds which were discussed under the law of reacting weights.
Information regarding a pure substance given by its formula (elemental composition, reacting weight).
Simple problems to find (1) the reacting weight of an element from the composition of its oxide, (2) the formula from the percentage composition, (3) the percentage composition of a compound from its formula.
The use of simple equations to represent the chemical reactions involved in experiments performed throughout the year. (Stress the fact that an equation is a record of a reaction which has actually occurred.)
Simple problems to show the use of the equation to calculate the relative weights of the substances taking part in a reaction.

NOTE:—The molecular formulae of the gases should be used in the equations and **may** be given at this stage without attempting to explain how they were determined.

Molecular formulae of gases.
(Four periods.)

Review the compressibility of gases.
Recall the barometer and the process of measuring atmospheric pressure.
Discussion of the measurement of the pressure of a gas in millimetres (or inches) of mercury, and in atmospheres.

Statement of (1) pressure-volume relationship of gases (Boyle's Law), (2) temperature-volume relationship of gases (Charles's Law), and the use of these laws in simple problems. Emphasis to be placed on principles.
Statement and discussion of Gay-Lussac's Law and of Avogadro's Hypothesis.
Information given by the molecular formulae of gases

Valency and nomenclature. (Five periods.)

Experimental determination of the valency of magnesium.
The application of valency in writing formulae.
The application of the rules of nomenclature in the naming of such binary compounds, acids, bases and salts as are met in the course.

Sulphur and its compounds. (Five periods.)

Sources of sulphur.
The preparation of the allotropes (rhombic, monoclinic, plastic).
Properties and uses of sulphur.

Demonstration of the preparation of hydrogen sulphide and its use in the preparation of metallic sulphides of silver, arsenic and antimony.

The laboratory preparation of sulphur dioxide.
The properties of its solution and its uses, e.g., bleaching and the production of sulphites (chemical wood pulp).

Properties and uses of sulphuric acid.

Reference to sulphur compounds in soils and plants and to the agricultural importance of such compounds as ammonium sulphate, copper sulphate, calcium sulphate and magnesium sulphate.
Test for soluble sulphates.

Common salt. (Four periods.)

A brief discussion of the commercial recovery and industrial importance of salt.
A study of its properties.
A study of the reaction of sulphuric acid and phosphoric acid with salt.

The laboratory preparation and properties of hydrogen chloride and of hydrochloric acid.

Sodium and potassium. (Four periods.)

The action of air on sodium and on potassium. Meaning of the term "potash" in relation to soils and fertilizers.
A review of the reaction of these metals with water.
A discussion of the properties of metals as illustrated by sodium and potassium.
A comparison of the properties of sodium hydroxide and potassium hydroxide.
The flame test for the presence of sodium and of potassium.

Importance of potassium in plant growth; solubility of compounds; lack of potassium in soils. Test for potassium in soils.

Phosphorus. (Five periods.)

Reference to yellow and red forms, phosphorus pentoxide and phosphoric acid; meaning of the term "phosphoric acid" as applied to soils and fertilizers. Forms of calcium phosphate and their relative solubility; importance of phosphorus to plant growth and loss from the soil; compounds which supply phosphorus. Test for phosphates in soils.

Chlorine, bromine and iodine.
(Six periods.)

Experiments to prepare chlorine in test tubes by the oxidation of hydrogen chloride (as hydrochloric acid). Reference to bromine.
A demonstration of the preparation and collection of chlorine and a detailed study of its properties.
An experimental study of the properties of an aqueous solution of chlorine.

A demonstration of the preparation and collection of iodine.
An experimental study of the properties and uses of iodine.
A comparison of the properties of chlorine and iodine.
Qualitative tests to identify a chloride and an iodide.

Compounds of nitrogen.
(Five periods.)

Recall the properties of nitrogen.

Laboratory preparation of nitric acid; its acid properties when diluted; its oxidizing action when concentrated; its uses; its toxic effect.
The properties and uses of such nitrates as those of sodium, potassium, ammonium and calcium.
The brown ring test for nitrates.

Laboratory preparation of ammonia, its properties and uses.
Properties of a solution of ammonia.
Brief discussion of the formation and properties of such ammonium salts as ammonium chloride and ammonium sulphate.

Importance of nitrogen to plants; loss of nitrogen compounds from the soil and replacement by nature.
Test for nitrates in soils.

Calcium and its compounds.
(Four periods.)

Recall the reaction of calcium with water.
Occurrence of calcium carbonate (limestone and marble).
Heating of calcium carbonate. The commercial preparation of quicklime. The slaking of quicklime.
Commercial uses of limestone, quicklime, slaked lime, gypsum, bleaching powder, calcium chloride.
Test for calcium in soils.

Soils.
(Eight periods.)

Soil profile: examination of a soil profile in the field; distinction between surface soil and subsoil; discussion of character of subsoil in relation to drainage, moisture retention and root penetration. Plant nutrients in soils. The essential nutrients for plant growth obtained from the soil. A brief discussion of plant nutrients in soil with special attention to those required by plants in larger amounts and which may commonly be deficient; functions of the four major nutrients in plant growth. Comparison of the amounts of nitrogen, phosphorus, potassium and calcium removed by crops and lost by leaching from the soil.

Organic matter and nitrogen; the importance of organic matter (humus) maintenance in relation to physical condition, moisture-holding capacity and supply of nitrogen in the soil.

Organic matter the storehouse of soil nitrogen: nitrogen made available by decomposition, ammonification and

nitrification; addition of nitrogen by nitrogen fixation by legume bacteria; free fixation by azotobacter and by rainfall (nitrogen cycle).

The value of crop residues, farm manures and green manures for supplying organic matter in the soil.

Manure and commercial fertilizers. (Fifteen periods.)

Review the meaning of the terms "nitrogen," "phosphoric acid" and "potash" as used in reference to manure and commercial fertilizers; the importance of farm manure as a fertilizer; losses in storage and methods of conserving plant nutrients in manure.

Examination of the following materials used alone or in mixtures to supply nitrogen, phosphoric acid and potash: nitrate of soda, sulphate of ammonia, ammo-phos, calcium cyanamide, blood meal; superphosphate, steamed bone meal; muriate of potash, sulphate of potash.

Tests to show the relative solubility in water and the presence of nitrate, ammonium or organic nitrogen in the nitrogen fertilizers; of water soluble phosphate in superphosphate or steamed bone meal; and of water soluble potash in muriate of potash and sulphate of potash.

The Fertilizers Act, Sections 1, 2, 3, 4, 5 and 9.

A review of the principles of soil fertility maintenance.